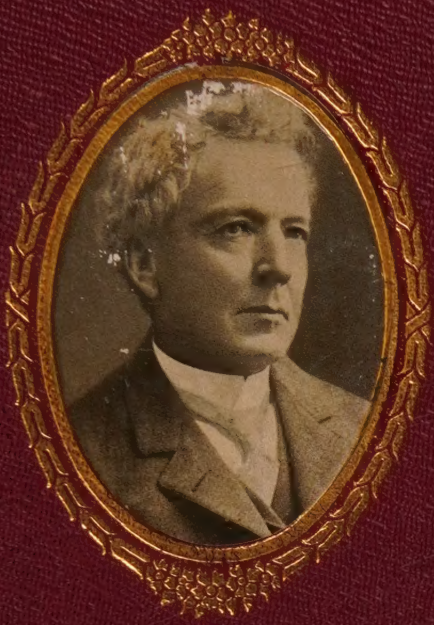

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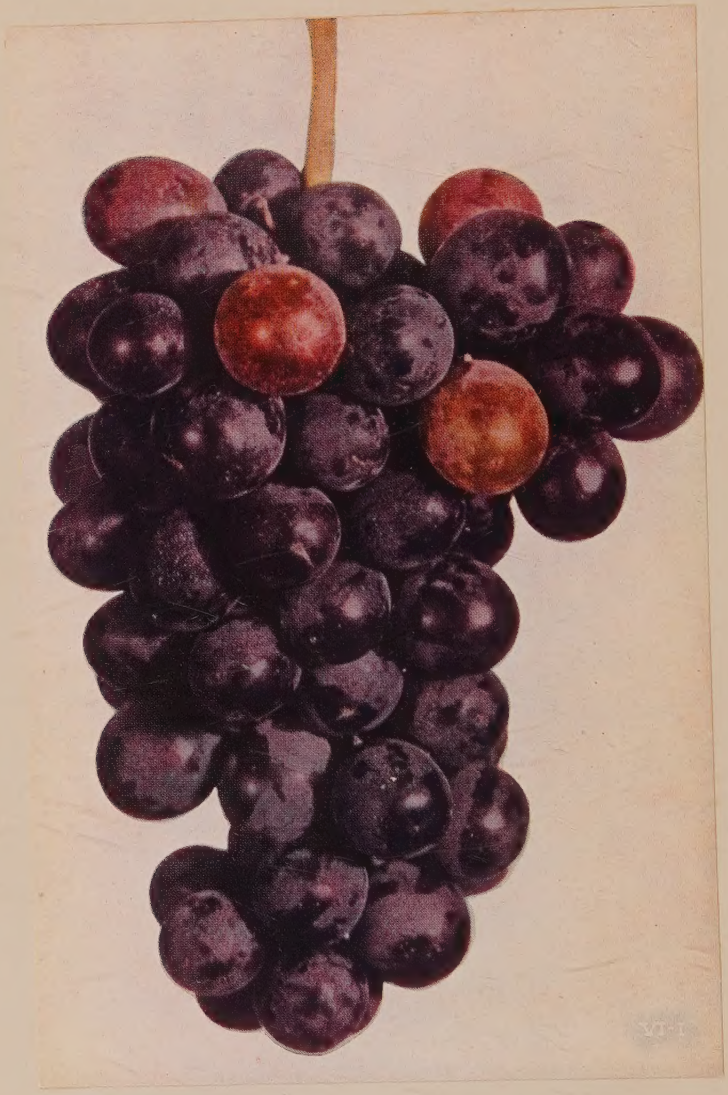

Burbank Seedling Grapes

These seedling grapes, of mixed heritage, are almost as large as plums. They are extremely early and of fine flavor; but they do not ripen evenly, as will be noticed. They have many good qualities to be retained, but several bad ones that must be eliminated through selective breeding.

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UNDER THE EDITORIAL DIRECTION OF

John Whitson and Robert John

AND

Henry Smith Williams, M. D., LL. D.

VOLUME VI

ILLUSTRATED WITH
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Volume VI—By Chapters

Foreword.....Page 3

I The Thornless Blackberry —And Others
—Some Transformations in the Bramble Patch..... 7

II The Raspberry and Some Odd Crosses
—Much Betterment—And a Few Baffling Problems..... 39

III Designing a Strawberry to Bear the Year Around
—And Other Work With Strawberries..... 73

IV The Sunberry—A Production From the Wild
—A New Food Plant From a Poisonous Family..... 105

V A Dozen Other Delightful Berries
—Offering Encouragement to Combine and Build..... 135

VI Great Opportunities In the Grape
—Generations of Grape Experiments Help Us..... 181

VII The Cactus Pear— A Profitable Fruit
—Its Flavors Fixed, Now Working Mostly for Seedlessness..... 213

VIII Some Inedible Fruits Which May Be Transformed
—Even the Acrid Barberry Is Changing..... 237

IX The Need for Improving Small Fruits
—And Some of the Means For Meeting It..... 269

List of Direct Color Photograph Prints..... 305

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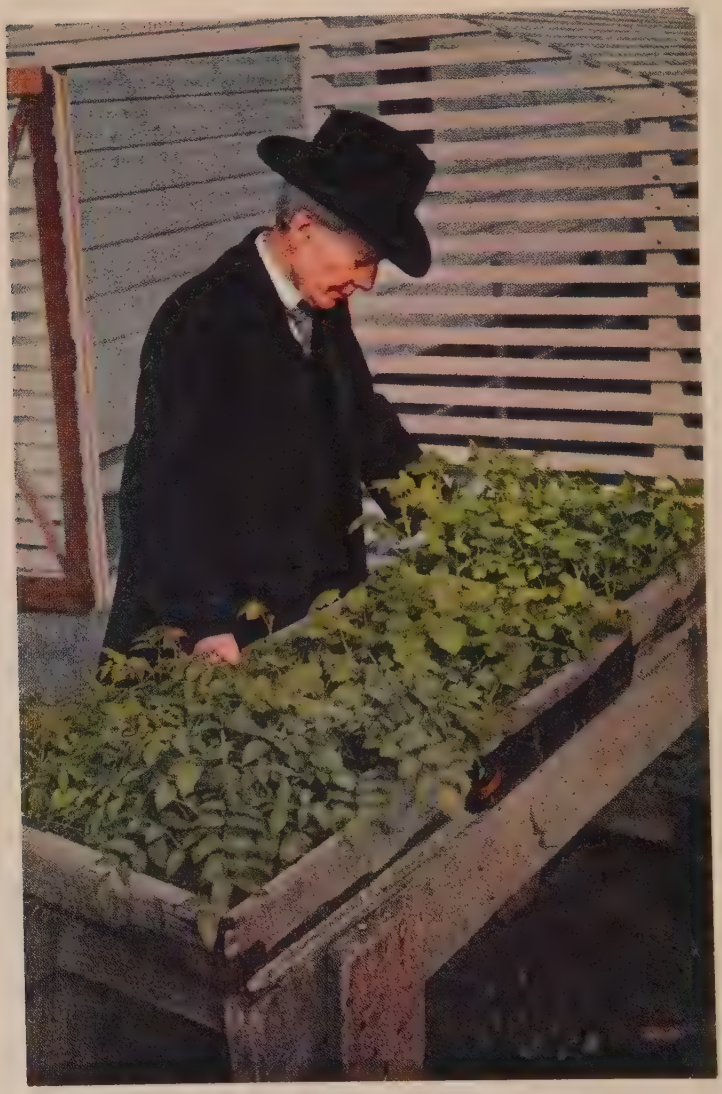
Foreword to Volume VI

In this volume Mr. Burbank tells how he produced the thornless blackberry, the white blackberry, the new thornless raspberry, and all of those other berry transformations which excite endless wonder in the minds of the uninitiated—yet which were produced by methods so simple, once understood, that they seem no more wonderful, after all, than their conventional cousins, with which, since childhood, we have been familiar.

In this, as well as in the other volumes, there are indications, and suggestions, wherever possible, of other improvements which are needed, and an outline of the ways in which there is likelihood that they may be brought about—with always a view to the practical betterment of existing berry patches.

THE EDITORS.



Mr. Burbank at Work

Mr. Burbank is here selecting among boxes of second-generation thornless blackberry hybrids. Some of these specimens are a cross between the thornless blackberry and the white blackberry; others between the thornless and the Himalaya blackberry. Through these experiments Mr. Burbank hopes to rid all of our best varieties of blackberries of their thorns.

The Thornless Blackberry —And Others

Some Transformations in the Bramble Patch

THE nursery rhyme about the wise man and the bramble-bush will probably have little meaning for our grandchildren. For the brambles of their day will have no thorns with which to scratch out eyes—let alone scratch them in again.

This, I think, is a fairly safe prediction, for the thornless blackberry is an accomplished fact, as anyone who has visited my gardens can testify; and the value of thornlessness in a berry-producing vine is so obvious that the new product can hardly fail to supplant the old type of briar bush quite rapidly.

Whoever has visited a blackberry or raspberry patch of the old type and attempted to gather the fruit, will recall, doubtless, bringing away souvenirs in the form of scratches that were far more lasting than the fruit itself.

[Volume VI—Chapter I]

When any visitor who has the recollection of such souvenirs visits my garden and sees mammoth clusters of beautiful blackberries growing on vines as smooth as pussy willows, the impression gained is both vivid and lasting that here is a plant improvement of a very notable order.

In point of fact, there is perhaps no other single plant development in connection with small fruits that constitutes so radical a change and so conspicuous an improvement as the removal of thorns from the blackberry. The bush itself no longer needs the thorns to protect it against marauding deer or sheep as it did in the days when it grew in the woodland or nestled in fence corners. On the contrary, as we have elsewhere suggested, the thorns are now detrimental to the plant in that they take a certain amount of energy and building material that might be put to a better use.

And from the standpoint of the horticulturist, the thorn is not merely a detriment; it is a nuisance of such significance as materially to interfere with the cultivation of the blackberry and very greatly to reduce its popularity.

It may confidently be predicted that, once the thornless blackberries are generally introduced, the really delicious fruit that they bear will be seen far more commonly in the market than it

Himalaya Blackberry Bush in Bearing

The Himalaya blackberry bush was grown by Mr. Burbank from seeds sent him from India. It is a wonderfully prolific plant, a single bush furnishing fruit to the amount of several hundred pints in a season. Unfortunately the stem is very thorny, but this is a fault that is to be remedied.

has been in the past, and will soon achieve the popularity that it deserves.

How the Blackberry Lost Its Thorns

As long ago as 1880, while I was still following the pursuit of a practical nurseryman and giving only incidental attention to plant development, I made experiments in the attempt to produce thornless berries. But these experiments were nearly total failures.

The plant with which I worked was a blackberry bush known as the Wachusetts Thornless, which was introduced and alleged to be thornless about 1880. I raised seedlings from this plant, and also crossed it with other blackberries. But I was much preoccupied with other experiments and was greatly handicapped for means, and therefore neglected to carry the experiments to a practical conclusion.

In point of fact the Wachusetts, which had been found partially thornless in the state of nature, had a goodly supply of thorns distributed here and there over the plant. It had fewer briars than most other blackberries, to be sure, but it was by no means the sort of bush to handle with impunity or rub against your face without the slightest danger, as may be done with the thornless blackberry of to-day.

The Wachusetts was not of a really smooth

stem, and it had almost nothing else to commend it. Its berries were quite small and lacking in flavor, and it had moreover the pestiferous habit of suckering from the roots. So it naturally did not achieve popularity. Nor was anything heard of any other blackberry that laid claim to thornlessness until about ten years later.

Then it chanced—in the year 1902 I think it was—that Mr. David G. Fairfield, of the United States Department of Agriculture, found in North Carolina a few plants of a wild dewberry, apparently *Rubus Canadensis,* that were nearly thornless. Mr. Fairchild had frequently furnished me specimens of one kind or another that he thought might be useful in my work. He now very kindly sent me a few ripe berries picked from the partially thornless dewberry.

The seeds were carefully planted in boxes in my greenhouse. Of the several hundred seedlings that these produced, probably about one or two in the hundred were nearly or quite destitute of thorns.

These few thornless plants were carefully selected, all the remainder being destroyed.

From the fruits borne by these selected plants, a second generation was raised, from among which it was possible to select a great number that were absolutely free from thorns—showing

no sign of any spicules on either stems or leaves.

More than fifteen thousand seedlings were raised from the fruit of the best of these thornless plants, and out of that large number not a single specimen showed any tendency to develop thorns, every one being as smooth as the branch of an apple tree.

Thus by inbreeding and selection from fruit produced by a partially thornless wild dewberry, I quickly developed a race of thornless berries that could be depended on to breed absolutely true as to thornlessness.

If we interpret the facts of this development, in the light of later experience, we may infer that the condition of bearing thorns is prepotent or dominant over the condition of thornlessness in the blackberry. Thornlessness is, then, a recessive trait which will be submerged in a cross between a thorny bush and a thornless one, but which will reappear after the manner of recessive traits, in a succeeding generation, provided two individuals of mixed heritage are interbred.

The fact that only a small percentage of my first seedlings grown from the seeds Mr. Fairchild sent were thornless, suggests that the flowers of the bush on which they grew had been chiefly fertilized with pollen from thorn-bearing bushes. The fruit from such a pollenization would pro-

Leaf Variations in a Hybrid

This very striking picture illustrates the range of variation that may be shown in a cross-bred plant. The solid leaf at the left resembles the California dewberry; the leaf at the right shows the characteristics of the Oregon evergreen blackberry —these two being the parental forms. The segregation of ancestral hereditary factors is strikingly shown in these hybrid blackberries.

duce thorny bushes exclusively, owing to the dominance of the factor for thorns. But if a few berries or individual drupelets of a berry had been fertilized with pollen from a flower of the thornless plant itself, these would (according to a formula with which we are already familiar) stand one chance in four of combining recessive factors and thus of producing thornless progeny.

And of course from there onward the case presented no difficulty. The plant experimenter was now at hand to make sure that the thornless flowers were fertilized solely with pollen of their own sort. This of course could bring together only recessive factors, that is to say, factors for thornlessness, and the result could not be in doubt. The thorn-producing factor would be left entirely out of the composition of bushes sprung from such a union, and they would inevitably be thornless.

Thornless, But Lacking Quality

But while the production of a thornless race of dewberries was thus accomplished with comparative ease, once the material with which to work had been supplied, it must be understood that this was really only the beginning of the task.

The original berries from which the thornless vines were grown were of no commercial value. They were small and of very indifferent flavor.

To have produced a thornless race from them was an interesting scientific achievement, but one that at this stage had no practical significance.

In order that the experiment should lead to the practical results at which I aimed, it was necessary now to improve the fruit of my thornless proteges. And, while something could be done in this regard by mere selection—in which case, of course, there would be no danger of having the plants backslide from a thornless condition—I soon found by experiment and observation that selection alone would be much too slow and doubtful a method for the development of such fruit as would be necessary to compete with the highly developed blackberries already in the market.

For of course it could not be overlooked that the ultimate purchaser is much more vitally interested in the quality of fruit supplied him than in the question of whether this fruit grew on a thornless vine or on a briar bush.

By the time I had reached the conviction that it would be necessary to adopt a more energetic procedure than mere selection in the education of the thornless berries, I had acquired through experience a very clear comprehension of the methods that must be depended on to inculcate the desired lessons. I knew that crossbreeding

afforded the only feasible means of introducing good qualities into the fruit of the thornless dewberries.

Now the work of development took on aspects closely comparable to those that we have already reviewed at length in the development of orchard fruits. It was necessary to bear in mind such items as increased size of fruit, good flavor, firm flesh, and time of ripening—all of these being matters regarding which the thornless berries were defective.

Improvement Through Hybridizing

Of course there was no dearth of material with which to effect hybridization.

The dewberry is merely a trailing variety of blackberry, and it crosses readily with all other species of blackberry.

I had at hand any number of blackberries bearing fruit of the finest quality. There would probably be no difficulty whatever in producing hybrids between the little thornless berry and the Lawton blackberry, for example, or my new Himalaya berry, or any one of a dozen others. And some of these would give, among varying seedlings, a certain member that would bear excellent fruit.

But, unfortunately, when such crosses were made, it was at once apparent that the thorny

Thornless Blackberries

At the right a thorny blackberry of ordinary type; at the left the thornless product; in the center an intermediate type. All gradations and variations of thorniness are shown among the multitudinous specimens developed in Mr. Burbank's long series of experiments in the production of the thornless blackberry.

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condition had shown prepotency, and all the seedlings that grew from thornless berries thus cross-fertilized were at once seen to be bearers of thorns.

This was precisely the experience that had disheartened me, when, back in 1880, I had made the experiments with the Wachusetts partially thornless blackberry, to which reference was made above. But in the intervening time I had made many thousands of hybridizing experiments, and I now clearly understood — what at the earlier period I had known vaguely if at all—that in such a case as this we must look to the second filial generation for the kind of results we are seeking.

The case is precisely comparable to that of the white blackberry, for example, or to that of the stoneless plum. When the white blackberry is crossed with a black blackberry all the offspring of the first generation are black. And when the stoneless plum is crossed with the stone-bearing plum all the offspring of the first generation are stone-bearers. But in each of these cases the succeeding generation will show individuals in which the submerged character reappears—we shall have white blackberries and stoneless plums again.

So I had every reason to believe that a comparable result would be achieved if the thorny

hybrid seedlings born of my thornless race were given opportunity to redeem themselves in their progeny.

The expectation was justified. In the second filial generation the thorny seedlings produced a certain proportion of thornless progeny. And these thornless bushes now bore fruit far superior to that of their thornless grandparent. They had inherited some of the good fruiting qualities of their thorny grandparent, even though they had repudiated his thorns.

This was obviously encouraging. So the experiment was continued along the same lines through successive generations. I selected, of course, the specimen in each generation that showed the best combination of desired qualities and hybridized, in successive generations, the Lawton blackberry, the giant Himalaya, and various others, to gain size of berry, earliness of bearing, new flavors, more acid, and, in a word, to supply whatever defects could be discovered.

The original thornless berry was a late bearer, and its fruit lacked size, spiciness, and refreshing acidity. But these qualities were supplied in good measure through successive crosses.

One seedling in particular, grown in 1906, showed exceptional qualities, and the subsequent stock was largely grown from the fruit of this sin-

gle bush. Like its fellows, it bore strains of half a dozen races of high-grade market berries, blended with the thornless strain.

Of course each successive hybridization with a bearer of good fruit meant the introduction of thorns in the seedlings of the next generation. This was inevitable, since of course all the bearers of commercial blackberries were bearers also of thorns. The Himalaya in particular is an exceedingly thorny bush, and the otherwise commendable Lawton is an almost equal offender. But whereas these thorny shrubs were prepotent in their influence over their direct offspring as was expected, some of their grandchildren always reverted to the thornless state.

And so here as in various other experiments already described, advance was made by indirection. We are forced to seesaw back and forth in successive generations between thorny bushes and thornlessness; yet on the whole there was progress, inasmuch as each successive generation showed better qualities of fruit, and each alternate generation the recurrence of the thornless condition.

Inasmuch as the thornless bushes, of whatever generation, will breed true to thornlessness if fertilized among themselves, it is obvious that each thornless generation constitutes a fixed race, pro-

Thornless Blackberry and the Recreant Seedling

At the left, a typical stem of Mr. Burbank's thornless blackberry; at the right, a thorny seedling. The thornless blackberry almost invariably breeds true to thornlessness; so it is to be surmised that this seedling is the result of a chance fertilization with the pollen of a thorny variety.

vided the plant experimenter does not elect to disturb its fixity by a new hybridization.

The result, up to date, is that after twenty years of selective breeding along these lines, the descendants of the little North Carolina dewberry (who are descendants also, of course, of various and sundry berries of more aristocratic bearing) constitute a race of blackberries growing on large, well-shaped, spreading bushes that are absolutely thornless. The fruit itself is a large, handsome, glossy black berry, of excellent flavor, profusely clustered—a fruit that makes inviting appeal to the wayfarer and which will exact no penalty in the way of scratches from those who gather it.

I have told thus at length the story of the thornless blackberry, because the development of this fruit quite eclipses all my earlier work with the blackberries, and makes the record of the development of the thorny varieties, however excellent their fruit, seem an almost archaic performance.

It must be recalled, however, that the present thornless blackberries of quality could not have been secured so expeditiously had not material been at hand for the hybridizing experiments through which size and flavor were bred into the fruit until, as just related, the perfected thornless varieties were developed.

The Himalaya and the Thornless

At the left, a typical stem of the Himalaya, which will be seen to be relatively slender and frail in contrast with the strong, sturdy stem of the Thornless, shown at the right. Thornless blackberry also shows improved leaf formation. Both plants are very vigorous and rapid growers.

And this material was largely the product of earlier experiments through which blackberries of the old type had been improved as to their fruiting qualities.

It is necessary, therefore, in the interests of completeness, to retrace our steps and briefly to review the earlier experiments—some of which, indeed, were carried forward coincidently with the development of the thornless—through which new races of blackberries of exceptional quality, though still handicapped by thorns, were developed.

In connection with this story it is interesting to recall that the cultivated blackberry is essentially an American product. No other country until quite recently has appreciated the quality of this fruit sufficiently to cultivate and develop it. Wild species, to be sure, are abundant in Europe, growing everywhere in England and in Ireland, along hedges and in waste places; but the horticulturist has all along seemingly been prejudiced against the fruit, partly perhaps because of its offensive briars.

The prejudice against the wild bramble was retained by the Colonial settlers of America—retained so persistently that fully two centuries were needed for this excellent berry to make its way into the fruit gardens.

ON THE THORNLESS BLACKBERRY

Not a single horticultural variety of blackberry was introduced until almost the middle of the nineteenth century. Then the Dorchester was brought to notice, and about a decade later a better berry, the Lawton, which is still a standard, and two other varieties, the Holcomb and Wilson's Early, were brought to the attention of fruit growers.

As a significant industry, blackberry cultivation is even more recent. It has almost wholly developed since 1870. It began with planting, on a commercial scale, the Lawton, which was later supplanted by the Kittatiny in some sections. This in turn gave way to the Snyder, and still more recently better varieties were developed. The evolution of the fruit had been gradual, but it has at last established a place in the horticultural ranks. I repeat my prediction that it will gain a new impetus now that the one great drawback of the blackberry, its thorny stem, has been eliminated.

It will take some time, however, to spread the thornless berry universally, and in the meantime the blackberries of the older type retain a measure of interest.

Materials for Development

The chief American wild species, which furnished material for the development of the races

just named, are the common Eastern blackberry (*Rubus nigrobaccus*), familiar everywhere throughout northeastern America, and a closely related form, considered by some botanists a mere variety, known as *Rubus sapivus*.

The common wild plant is an upright grower, stout, has little recurving canes that are usually deeply furrowed lengthwise, and clothed with stout more or less hooked prickles.

The other species or variety is slightly more erect, with fuller and firmer canes, differing somewhat also as to shape of leaves. It bears berries that are usually rounded, generally soft and juicy, and of superior flavor. At my old home in New England this variety grew abundantly on sandy soil, being one of the best wild blackberries in that vicinity. I early noticed that this plant was inclined to vary widely. For example, the vines, although usually stiff, upright growers, sometimes more resembled the common blackberry, or even tended to take on the trailing habits of the dewberry.

When I came to know more about plant development I recalled this tendency to variation, and felt that here, as always, a fruit of this tendency should furnish material for the development of improved varieties.

In due course I worked with the various culti-

vated varieties of blackberry, and soon developed some improvements, particularly with reference to the size of fruit, its flavor, and lengthening the season of fruit bearing.

One of the improved varieties with which I worked had been lately introduced under the name of the Early Harvest; another was named Wilson Junior. But my most notable results attended the use of the native species, and in particular the introduction of foreign species from remote parts of the earth.

As early as 1879 I was earnestly working on varieties of blackberries, and of raspberries as well, that were obtained from my collector in Japan, combining these with other wild and cultivated varieties from various sources.

My first really notable success, however, came about through selection, without the aid of hybridizing, from a berry that I introduced from India. This berry, in recognition of its origin, was named the Himalaya, sometimes shortened to Himalya.

The Prolific Himalaya

The seed from which this improved blackberry grew was obtained from India through exchange.

It would appear that transplantation to an altogether new soil and climate had the same stimulating effect upon this blackberry that we

A Thorny Climber

Beside the back fence of Mr. Burbank's garden at Santa Rosa there grow, within a few feet of each other, two blackberries which never fail to excite wonder. One is the typical thorny type shown above; the other is the absolutely smooth thornless blackberry—a complete transformation. The warlike capacities of the thorny blackberry bramble are familiar to everyone who has ever gathered blackberries.

A Thornless Contrast

This is the thornless blackberry growing beside the thorny one shown in the preceding picture. Not only have the thorns been completely removed, but the cane, as can be seen, has covered itself with a downy film, comparable only to the bloom which grows on plums. The plant shown here has possibly 100 feet of stalk and stem, every inch of which could be rubbed across the face without injury.

have seen manifested in the case, for example, of the Japanese plum, the New Zealand winter rhubarb, and sundry other plants. For there appeared among seedlings of the second generation an individual that showed a very marked improvement over its parents.

This exceptional seedling was cultivated and propagated, and its qualities proved so unique that it was introduced in 1885 by a special circular, being christened, as just stated, the Himalaya.

After the usual decade or so of probation, during which every new fruit of whatever quality must wait for recognition, the Himalaya took its place, first on the Pacific Coast, and later throughout the northern and central states, as a standard blackberry. After it came to its own, so to speak, its popularity was so great that for several years the plants could not be multiplied fast enough to meet the demand.

It is a plant of extraordinary vigor. A single cane may grow more than twenty-five feet—sometimes even fifty feet—in a season, and attain near the base a diameter of an inch to an inch and a half.

The aggregate growth of cane of a single plant in a season may exceed a thousand feet—one fifth of a mile.

And in point of fruit production, the Himalaya

Thornless Blackberry Buds

The thornless blackberry is of mixed ancestry, the progenitor from which the thornless quality is inherited being a wild dewberry. Thornlessness in a brier seems almost a contradiction of terms, but it will be seen that the buds and leaves have characteristic blackberry qualities.

far surpasses any other berry plant ever grown. Reports tell of a single bush bearing two hundred pounds of berries in a season.

"My daughter and I picked fifty pounds of berries from one Himalaya bush the latter part of August, 1906," writes one enthusiast, "and we scarcely missed them from the bush. This was after many others had picked from the same bush. I picked three pounds standing in one position. I could have picked double that amount if I could have reached into the bushes farther, but the entangled branches with their sharp thorns prevented me."

The narrator adds this comment: "It is my opinion that if this bush were properly pruned, fertilized, and irrigated, as well as shaded from the extreme heat of the sun in July and August, it would bear between three and four hundred pounds in a season."

Such a report is typical. The prolific bearing of the Himalaya is the subject of astonished comment from everyone on seeing this extraordinary vine for the first time.

The fruit itself is of medium to large size, unusually sweet, and spicy, with small seeds, and fine in quality. The berries grow in clusters sometimes a foot or more across, and they continue to ripen after most other blackberries are gone.

Blackberry Blossoms

As to blossom also, the Thornless is a typical and characteristic blackberry. The smooth stem may make one doubt, but observation of the flower will convince any pessimist that this is a true blackberry.

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If not pruned, the vines of the Himalaya will grow to a length of one hundred feet or more, like grape vines. They appear to be absolutely resistant to disease, and they have recently shown the ability to resist the extreme cold of Michigan and the far northern states. It should be known that the Himalaya takes a year or so more to come to its best bearing condition than ordinary blackberries, but when in full bearing a single plant will produce as much as a dozen ordinary blackberries.

The elimination of the thorns is a matter to which sufficient reference has already been made. As to abundant bearing, nothing more is to be desired. The Himalaya at present produces all the berries that a vine can possibly support.

Development Through Hybridization

As the experiments in the development of the blackberries continued, I quickly passed from the stage of mere selection to that of crossbreeding and hybridization.

The plants utilized in these experiments included not only all types of native blackberries proper, and numerous foreign species, but plants of the allied race of dewberries.

The dewberry, to be sure, is closely related to the blackberry; it is, indeed, a blackberry that has assumed a trailing habit. Or possibly the case

would be stated more truly if we say that the bush of the blackberry is a dewberry that has risen from the ground and assumed the habit of upright growing.

There is, nevertheless, a sufficient divergence to make the dewberry seem to casual inspection a plant of distinct type. And, at the time when my experiments were begun, there were probably few plant developers who would have supposed it possible to hybridize even the dewberry with the ordinary blackberry.

Successive crosses were effected, nevertheless, at an early stage of the work, and in the course of my experiments the interblendings were so numerous and intricate that seedlings were produced showing all gradations of habit between the trailing vine and the upright one; as well as all gradations of leaf and fruit form and quality.

Sometimes in crossing a blackberry with a dewberry the trailing habit is greatly intensified, the hybrid being a long, vine-like, straggling plant. Again, the result may be just the opposite, a tall, upright, almost tree-like plant being produced. Some hybrids would run a distance of at least fifty feet. Others, perhaps of the same fraternity, would take on so tree-like a habit that their fruit could be reached only with the aid of a step-ladder.

But perhaps the most singular and interesting anomaly was that some of these hybrids bore flowers and fruit in every month of the year, though sparingly. At the time when I had a large colony of blackberry-dewberry hybrids, ripe berries could be picked from one bush or another almost every day of the year.

The possibility of producing, with the aid of such hybrids, commercial varieties of blackberries that will fruit at all seasons is inviting. Experiments already far advanced have greatly extended the blackberry season, and there is reason to expect that the blackberry lover in the future will be able to secure this fruit, in one variety or another, from early spring until almost the onset of winter.

As to other possibilities of blackberry development, something was said in the earlier chapter that described the development of the white blackberry. But much remains to be told. The chief development, however, through which not merely new varieties but new species of berries have sprung from the amalgamated stock of the forty-odd species of bramble fruit with which I have experimented, have had their origin in hybridizations that linked the blackberry with its relative the raspberry.

The account of the altogether notable results

Proof of the Pudding

Should any doubt remain that this curious plant with its absolutely smooth stem is really a blackberry, a test of the fruit will at once convince the most sceptical. Not only is this a thornless blackberry, but it is a fruit of very excellent quality. It has the peculiarity of maturing very late in the fall.

that have arisen from this alliance is an integral part of the story of the blackberry. But it may be told to best advantage in connection with the story of the raspberry in the succeeding chapter.

—The thornless blackberry is an accomplished fact, and the value of thornlessness in a berry producing vine is so obvious that the new product can hardly fail to supplant the old type of briar bush quite rapidly.

The Raspberry and Some Odd Crosses

Much Betterment—and a Few Baffling Problems

LET us take up the story of small fruit development where the preceding chapter left it. We are still concerned with the blackberry, but we now have to do also with the companion fruit, which is obviously a not very distant relative, yet which has certain typical peculiarities that mark it as belonging to an altogether different branch of the race of brambles. Most conspicuous of these is the fact that the ripe raspberry separates from the receptacle when picked, whereas the blackberry is permanently attached to the receptacle.

The raspberry, unlike the blackberry, has been cultivated in Europe from an early period. The red raspberry, in particular, grows wild all over Europe, from Greece to Spain and northward to Norway and Sweden. It was originally christened *Rubus Idaeus,* after Mount Ida in Greece.

Like other cultivated plants, it tends to vary, and it is said that more than twenty varieties were under cultivation in England a century ago.

The American colonists introduced this favorite European berry at an early date, but it did not find a congenial environment in the new country. The long, cold winters of the northern states, and the dry heat of the southern summers were alike hostile to it; and its lack of hardiness denied it general recognition except as an occasional garden plant.

But the new continent possessed many wild raspberries that were of course adapted to the environment, and in time these came under cultivation. Their introduction, however, was so gradual that it was quite unnoticed. The only raspberry cultivated extensively for the New York market early in the nineteenth century was known as the English Red. It is believed to have been an offspring of a native berry, known as *Rubus neglectus* (itself believed to be an accidental hybrid of our wild red and black raspberries), but this was not generally known, and the name given the fruit suggests that it was supposed to be of European origin.

During the latter half of the nineteenth century many improved red and yellow raspberries were introduced, and various of these have been

The Familiar Blackcap

This is the familiar wild black raspberry or Blackcap, sometimes spoken of as the Longworth Blackcap. The specimens here shown are better than the average run, having been improved by Mr. Burbank by means of selection. They represent the species unmodified by crossing, however.

[illegible] Clara County
Library
[illegible]

utilized in the course of my hybridizing experiments.

But perhaps the chief favorite among American raspberries is the one introduced in the early forties by Nicholas Longworth, of Ohio, and known as the Wild Black or Black-cap Raspberry, *Rubus occidentalis.*

This berry was a great addition to the list of cultivated fruits. It soon became a favorite everywhere it could be successfully grown. Mr. Longworth himself introduced it into England, but it did not thrive in the English climate and it never competed with the native European species.

Interbreeding the Raspberries

The familiar cultivated raspberries of the present time owe their origin to the species just named, and to two other allied species, one our wild red raspberry, *Rubus strigosus,* a close relative of the common European species, the other known as *Rubus leucodermis,* a western relative of the familiar black-cap.

All the red raspberries now under cultivation have sprung from either the European or American red species. The Purple-cane type apparently sprang from the *Rubus neglectus* (very probably a hybrid between *R. strigosus* and *R. occidentalis*); such varieties as the Reliance, Shaf-

fer, Philadelphia, and Gladstone are, at least in part, probably of this origin, as was the historical English red. The Purple-cane was a native of the northeastern part of the United States, being especially common in New York.

The original American red raspberry, *Rubus strigosus*, first became known to the horticultural world in 1860, through the introduction of Allen's Antwerp and Allen's Red Prolific.

For several years preceding 1880 I had been raising seedlings of blackberries, raspberries, gooseberries, Juneberries, strawberries, currants, and various other berries on my experiment farm, and many variations were developed in that way which aroused my enthusiasm.

These experiments were largely instrumental in teaching me the then not known or not generally accepted value of cross-pollenizing as the means of introducing the tendency to vary among existing species or varieties. And my experiments with the different raspberries had a prominent share in the demonstration of this very important and hitherto unappreciated principle.

In the course of these experiments it was first found that the black-cap would cross with the red raspberry, although with difficulty.

Seedlings from this cross sometimes bore perfect berries abundantly, but much oftener they

bore imperfect berries having perhaps only two or three seeds. Again, after blooming, there would be no development of fruit, only a core or stem remaining.

Among some of these crosses I met with a difficulty not encountered in crossing any other of the members of the great Rubus tribe. The plants at first seemed sickly, having little or no vitality. When transplanted from greenhouse to open field they made little growth the first season and the second season at about the time for fruit bearing they all seemed to fail utterly.

Every seedling among a lot of these hybrids would sometimes thus be suddenly destroyed.

In continuing the experiment, I found that there was strong individuality among the different plants, so that some of the red or yellow raspberries crossed readily with the black-caps, while others failed to do so; there being all gradations. In some cases the resulting seedlings would show the prepotency of one parent or the other. But, generally, in the first generation, there would be a blending of the characteristics of the two.

Underlying Principles

At that time no plant developer fully realized that all the best variations and recombinations in a hybrid stock appear in the second and a few succeeding generations. A recognition of this

The Eureka Raspberry

This was the first of Mr. Burbank's cross-bred raspberries to be perfected. It was introduced in 1893, and was described as "larger than any raspberry in cultivation"; bright red, very productive, and similar to Schaffer's Colossal in its piquant acid flavor." The experiment through which the Eureka was produced furnished invaluable lessons in heredity.

principle constituted my first very important step toward the development of new forms of plant life.

I discovered, in connection with the raspberry hybrids, that in the second and a few succeeding generations different combinations were brought out in the most wonderful variety; and that from these certain individuals could be selected having almost any qualities of either parent combined in almost all possible proportions, and often greatly intensified.

This was, as we now know, substantially the discovery that Mendel had made almost twenty years before. But no one heard of his discovery till long afterward (about 1900), and at about the time when I was independently learning the same lesson Mendel himself died, quite unknown to fame, without having been able to bring his discovery to the attention of the scientific world.

Meantime, without formulating the principle in precise terms as Mendel had done, and without following up results with numerical exactness, I came to full recognition of the principle of blending of characters in the first filial generation and their reassortment and segregation in the second and succeeding generations.

All my experimental work was carried forward with a clear recognition of that principle.

As to the work with the raspberries, my first aim was to accumulate as much available material as possible.

This has been my custom throughout. The chances of obtaining results from a large number of experiments are proportionately greater as the number increases, and I find, within limits of time, that it is just as simple to conduct a thousand or ten thousand experiments, or even a hundred thousand experiments, as to conduct a few.

So I worked on a comprehensive scale with the raspberries from the outset; and it was not long before I developed several varieties of value; varieties, in fact, superior in size, quality, and productiveness, to any raspberries hitherto known.

First Fruits of the Experiments

The first of my new raspberries offered to the public was named the Eureka.

This raspberry, introduced in 1893, was described as "larger than any raspberry in cultivation; bright red, firm, very productive, and similar to Shaffer's Colossal in its piquant acid flavor. It is nearly twice as large as Shaffer's Colossal, its great-grandparent, and a better color and quality, firmer, handsomer, and in all respects an improvement on that well-known variety. The bushes are more compact in growth, almost free from prickles, and of a sturdy appearance."

Particular attention should be called to the fact, just stated, that the new raspberry was almost thornless. This was true of a number of my raspberries, as by selective breeding I was able to give these vines smooth stems at a time when my similar attempts to remove the thorns from the blackberry had not been successful.

The difference was due, perhaps, to the fact that the raspberry, having been long under cultivation, had partly lost its thorns through more or less unconscious selection on the part of many generations of fruit growers. The thorns had been reduced in many varieties to prickles, and occasionally individual specimens appeared that lacked even these. By selective breeding from such specimens I was able to produce varieties that had practically smooth vines.

A selected seedling of the Eureka was remarkable for its habit of bearing in October as well as for the enormous size of the berries, which were frequently almost four inches in circumference. The berries were of a beautiful bright red, but were rather too soft except for home use.

Another of my crossbred raspberries, originated at the same time with the Eureka, was called the Dictator. This also is a mammoth bright red berry. It combines the flavors of the Gregg and Shaffer's Colossal from which it orig-

Thornless Raspberry

Among other things, the experiments that produced the Eureka pointed the way toward the development of a thornless raspberry. The stems here shown sufficiently demonstrate that this ideal was attained. A picture of the thornless raspberry has been given in Volume I.

inated. The combination is one of the happiest, as the acidity of one is modified by the sweetness and aroma of the other. The berries were more than three times as large as those of the Gregg, and almost twice as large as those of Shaffer's Colossal, which until the production of these new hybrids bore the largest raspberries known.

Another cross of the Gregg, this time with the Souhegan, produced a seedling that had astonishing crops of fine, medium-sized, red berries, that ripened during October. The Souhegan was also crossed with the Shaffer, and this union produced in the second generation a new variety that was known as the Sugar.

From the seeds of other members of this same generation two or three other promising berries were produced. One of these bore large, firm berries, conical shaped, and a dark rich purple color.

A New Species—The Primus Berry

All the raspberries commonly known to the cultivator, and many new ones that I imported from Asia and the Southern hemisphere, were growing on my grounds from 1890 to 1900, and were intercrossed very extensively. Numbers of highly interesting hybrids were thus produced, and at least one of these was of so distinctive a character as to merit the title of a new species.

The Dictator Raspberry

This was another of the crossbred raspberries originated at the same time with the Eureka. This also is a mammoth bright red berry. It combines the flavors of the Gregg and the Shaffer's Colossal, from which it originated. The combination is one of the happiest, as the acidity of one is modified by the sweetness and the aroma of the other.

This was the fruit that was introduced as the Primus berry.

This highly interesting fruit, one of the first plants of any kind that could properly be termed a new species to be developed under the direct guidance of the hand of the experimenter, was the progeny of a hardy little berry indigenous to Siberia and Russia, called the Siberian raspberry (*Rubus crataegifolius*), and the California dewberry.

The little hardy Northern raspberry bore fruit about the size of a pea, of a dark mulberry color, with rather large seeds, and a flavor not such as particularly to commend it. It is, however, remarkable for its large palmate leaves, and the sturdy growth of its stems.

The California dewberry, *Rubus bitifolius,* is a trailing vine which is extremely variable in foliage, habit of growth, size, and quality of fruit. It is found wild everywhere in the foothills and lower elevations throughout the Pacific slope of the United States, but seems to be at its best in Northern California and Oregon. The berries of this wild species are often produced abundantly. They are black, usually of good size, and of superior quality. They are often gathered in large quantities for market and home use.

The fact that the dewberry bears so-called di-

The Primus Berry

This highly interesting plant is one of the first that could properly be termed a new species developed under the direct guidance of the hand of the experimenter. It is the progeny of the California dewberry and a hardy little berry indigenous to Siberia and Russia, called the Siberian raspberry. The remarkable Primus berry appeared as a first generation hybrid, and it breeds true, having the characteristics of a new and permanent species.

oecious flowers—that is, flowers of opposite sexes on separate plants—has discouraged a very general cultivation of the plant. It is necessary to grow both male and female plants to ensure fertilization, and fruit growers do not relish the idea of having half their vines unfruitful.

Nevertheless there was one variety of the California dewberry, called the Aughinbaugh, which had been under cultivation for several years. This was the one selected for most of my experiments in hybridizing the dewberry; and this plant had a share in the production not only of the Primus berry, but of the even more remarkable Phenomenal berry to which reference will be made in a moment.

The cross between the Siberian berry and the California dewberry, from which the Primus sprang, was made without particular difficulty. I had learned by this time that blackberries and raspberries and dewberries could be hybridized almost indiscriminately; and the fact that one of the parents in the present combination had grown originally in Siberia and the other in California offered no barrier to the union.

With the first lot of seedlings, five hundred or more, from this union of the California dewberry and the Siberian raspberry, some strange specimens were revealed.

A Natural Hybrid

This natural hybrid raspberry was found growing wild by Mr. Burbank in Alberta, Canada. It was brought to Santa Rosa, and has been used in various hybridizing experiments. The chief interest of the plant, however, is that it is a natural hybrid that was growing in a state of nature, and apparently competing successfully with both of its parents.

Nearly all were worthless plants, some of which seemed hardly to have vitality enough to live, much less to produce fruit. Others bore small, unattractive berries, insignificant in every respect. Three or four individuals, however, grew with unusual vigor. They differed so widely from the others that I was at first inclined to suspect that they were dewberries unhybridized. As to this, however, I was in error.

One of these exceptional vines was particularly notable. It neither trailed nor stood upright, but took an intermediate position. The leaves were not palmate like those of the raspberry, nor were they like the foliage of the dewberry. They were a compromise between the two.

The fruit, which was larger than that of either parent, resembled the blackberry most in form, but was of a dark mulberry color.

When the fruit was just ripe it parted from the stem like the blackberry; but when fully mature the core came out as it does in the raspberry.

Thus the combination of all these important characteristics was almost absolutely complete. The hybrid was a perfect blend.

It was this plant that was christened the Primus berry.

Seedlings by the thousand were raised from this selected hybrid and all of them came as true

as the seeds of any wild species of the family. The offspring closely resembled the Primus, but none of them quite equaled it in fruiting qualities.

If found growing wild, the original Primus plant and its progeny would be pronounced by any botanist a distinct species.

The explanation of the summary production of a hybrid differing in this remarkable manner from either parent and being so fixed in type as to breed true to the new form thus suddenly developed would seem to be that the two parent species were separated almost to the limits of affinity. The fact that most of the hybrids of the same generation with the Primus were feeble and degenerate creatures is corroborative. It appeared, however, that there were elements in the two types of germ plasm that if combined in just the right way would produce a virile offspring.

By chance the right combination was effected, and the Primus berry was the result.

The berry itself has not proved a great commercial success, but that is a matter of small importance. The real importance of the experiment was in what it proved as to the possibility of the production of new species through hybridization. This was, in short, one of the first instances to come under my observation of the production of a hybrid that blends the characteristics of the

parents, producing a new type and breeding true to that type.

To my mind—and I think the facts are convincing to any unprejudiced mind—this and many similar experiments that have been successfully accomplished demonstrates beyond dispute that hybridization is one of nature's methods of creating new species.

I have dwelt at length on this subject in earlier chapters. I revert to it here because of the importance of the subject itself, and also because the Primus berry furnishes us a new and striking illustration of the truth of the principle.

Of course the Primus berry was produced by artificial pollenizing of the plants that were so located geographically that they would have had no chance to hybridize unless brought together by man. But my observations show that natural hybrids are not at all unusual among wild members of this family. I have met with them often where two or three closely related species were growing side by side.

Near Lake Sycamour, for example, at Alberta, Canada, I have observed two common raspberries, *Rubus leucodermus,* a red raspberry, and *Rubus strigosus,* a black-cap, growing in close proximity around the hillsides and along the streams.

In every case where I found these two species growing together there were numerous natural hybrids in evidence. None of these hybrids were as productive as the parents, but the vines were usually stronger growers than either, and appeared to be hard pressing both parent species, with the prospect that they would in time supplant them in this region. I gathered large quantities of seeds from the best of these hybrids and brought them home for planting. Many seedlings were thus raised which obviously carried the combined characters of both their wild parents.

These representatives of a new species developed by hybridization under natural conditions have obvious scientific interest even though they failed to develop sufficient productivity to be of commercial value.

Let me repeat that natural hybrids are much more numerous than is generally supposed.

I have found them among other wild plants. Especially are they to be observed among strawberries, blueberries, huckleberries and California lilacs (*Ceanothus*). I have elsewhere cited instances of the hybridization of the tar-weeds and the mints. There can be no doubt that some of our well-known species of to-day were produced by Nature in this way within recent times.

I have elsewhere observed, and I emphatically

repeat, that any theory of the origin of species that does not recognize this among the methods employed by Nature for the production of new species is altogether inadequate.

Another New Species—The Phenomenal Berry

The result of thus mating the dewberry with the little raspberry from an almost Arctic climate having proved so remarkable, almost numberless tests were made in which the dewberry was crossed with a great variety of other raspberries and blackberries.

And among the hybrids thus produced there was at least one that might be considered more remarkable even than the Primus berry.

This was the fruit which afterward became famous as the Phenomenal berry.

This extraordinary berry was the outcome of a series of experiments in which the red and yellow raspberries were variously combined with the dewberry.

In the first generation of these hybrids, numerous red berries and black berries were produced, but no yellow ones. A large proportion of the red varieties followed the raspberry in general characteristics except in form, but some of them acquired the high flavor of the dewberry combined with the aroma of the raspberry.

Most of the seedlings of this first generation

The Phenomenal Berry

This also is a new species introduced by hybridization. Its parents were the California dewberry and the Cuthbert raspberry. Unlike the Primus berry, it is not a first-generation hybrid. It appeared in the second generation. The name "Phenomenal" is fully justified both because of the origin of the plant, and because it bears fruit that is perhaps larger than any other berry hitherto seen.

resemble the wild dewberry in habit of trailing along the ground. Yet there were some that favored the raspberry, standing upright. In flavor many were a good combination of the two parents, but the variation was pronounced in this respect. Some were highly flavored while others were quite insipid, and between the two were all gradations. Variations in size and shape were equally marked.

Most of these seedlings were quite productive, but no one plant was sufficiently valuable to warrant its introduction as a new variety worthy of cultivation.

Berries were gathered, however, from the most promising of the dewberry-raspberry hybrids. Among the second-generation seedlings thus produced was one that was of different caliber from all the rest as shown by the character of its fruit.

No such berries were perhaps ever seen before as those that grew on this second-generation offspring of the Cuthbert raspberry and the California dewberry.

Some of the berries were an inch and a half long and an inch in diameter. They were a dark rich crimson color, slightly downy, and glossy. In flavor they combined the qualities of raspberry and blackberry, both flavors seeming to be intensified. In a word the fruit was a blend be-

The Phenomenal Berry

The color print shows this remarkable berry much reduced in size. Many of the berries are an inch and a half long and an inch in diameter. In flavor the Phenomenal berry combines the qualities of raspberry and blackberry, both flavors seeming to be intensified. Its individual qualities are so marked and distinctive that it is entitled to be designated a new species.

tween the fruits of the parent races. It was a new variety so markedly distinct from either parent as to justify the designation of a new species.

The new berry was originally called the Humboldt, but was subsequently rechristened the Phenomenal by the purchaser.

The new fruit was not altogether unlike the Loganberry, which was an accidental hybrid discovered by Judge J. H. Logan on his place near Santa Cruz, which was believed to be a hybrid between the red raspberry and the California dewberry. But the Phenomenal is far superior in size, quality, color, and productivity, and it is gradually displacing the Loganberry.

Unfortunately the two are sometimes confounded, and unscrupulous dealers have been known to sell the Loganberry under the name Phenomenal.

The new fruit, like most other plant developments—the Burbank plum, the Wickson plum, and the Pineapple quince, for example—was not fully appreciated for about ten years. But it is now a standard berry on the Pacific Coast, and as far as possible it is being introduced in other regions wherever it will thrive. As already noted, it is probably the largest of all known berries. As a fruit for drying and canning it is of the first importance.

From the standpoint of the plant developer the Phenomenal is of additional interest because of its almost exact combination or blend of the qualities of its parents.

I have raised numerous seedlings from the Phenomenal, but up to the present have found none that quite equals it in all its excellent qualities, though, like the Primus, it is a fixed new species, the seedlings not reverting to either parent form. The new berry has also been used as seed parent in a number of crosses with other blackberries and raspberries.

Some thousands of seedlings thus produced are now under observation.

Among these hybrids great variations will of course, occur, and while nearly all will undoubtedly be of inferior quality, I have confidently expected to find at least one that surpasses even the Phenomenal; and now this expectation has been fully realized in a new sweet variety which will later be introduced.

Other Perfectly Balanced Hybrids

Hybridizing experiments of almost equal interest, even if not quite so striking in results, have been made between the various raspberries and the Lawton blackberry.

The Lawton is a very prepotent parent in these crosses, and its characteristics will almost invari-

ably be found to predominate. Even the pollen of the Lawton when applied to the raspberry more often produces the Lawton type of berry than any other type. But in exceptional instances I have produced Lawton hybrids in which the prepotency was not so strongly manifested.

Such was the case, for example, with a cross between a yellow raspberry known as the Golden Queen and the Lawton. This produced a hybrid so well-balanced that no one who saw it could tell whether it was a raspberry or a blackberry.

Numerous seedlings of this hybrid strain were raised, and in the second generation the qualities of the hybrid were reproduced, as in the case of the Primus berry and the Phenomenal. No variation occurred such as is usual in the second generation of most hybrid blackberries and raspberries.

The bushes had prickles that were short and stout instead of long and slender as in the raspberry. The leaves also had the rough, ribbed appearance of the blackberry.

The berries would cling to the receptacle (a blackberry trait), or part from it (a raspberry trait), according to ripeness. As to color, there were both red and yellow varieties among the hybrid plants. The flavor of the berries was not exceptional, but in some other similar crosses

Hawaiian Raspberries

This interesting berry is of very good quality, but does not last long enough for market purposes. Mr. Burbank is using this plant for hybridizing experiments. The experiments are still under way, and give promise of very interesting and perhaps important results.

made at a later period the fruit was in some cases greatly superior in quality to that of either of the parents.

Still greater interest attaches, perhaps, to a hybridizing experiment in which the parents were Shaffer's Colossal raspberry and the Crystal White blackberry.

Some of the plants from this cross were of the most tree-like proportions. Most of them, however, were barren, though they bloomed freely. But there were exceptional ones that fruited, and selected seedlings were grown from these through a series of generations. In the fourth generation a plant appeared which was of such extraordinary characteristics that it was given the name of Paradox.

This plant was in all respects a most perfect combination of the two ancestral forms from which it sprang. The wood, bark, leaves, blossoms, prickles, roots, and seeds could not by any test be proved to be like one or the other. The fruit, produced in abundance, was an oval, light red berry of good size, larger than that of either progenitor, and of fair quality.

Many of the first generation descendants of the Paradox were partially barren, though blooming freely. Sterility as to fruit was often associated with gigantic growth.

An Alaskan Raspberry

This Alaskan berry has qualities that entitle it to consideration on its own behalf, at least in the region where it is native. Mr. Burbank is using it in hybridizing experiments; and his success with the Siberian raspberry and other types of wild fruit leads him to think that interesting developments will result from the combination of the Alaskan berry with other races.

But some of the seedlings were fertile, and they manifested almost every possible combination of qualities of the raspberry and blackberry. Some were similar to the Paradox, except that they had white berries instead of red.

By saving seeds from the white and the red varieties separately, I found that they bred true, each constituting practically a fixed species.

As to the vines themselves, there is very little variation, the canes and foliage presenting an exact balance between the raspberry and the blackberry.

The berries are not of great commercial value, as the fruit though large is soft. I hope, however, to harden the berry by selective breeding, and introduce a better flavor.

Although this hybrid progeny of raspberry and white blackberry may ultimately have commercial importance, it is chiefly prized for the scientific significance of its revelations.

Descended as it is from a cross between the raspberry and the blackberry, it constitutes a fixed species differing radically from every other *Rubus* known.

So in this regard the Paradox takes its place besides the Primus and the Phenomenal berries as offering an impressive object lesson in the production of new species by hybridization. Let it

An Interesting Hybrid

The fruit here shown is a cross between the yellow-golden Queen raspberry and the Lawton blackberry. It possesses qualities of both blackberry and raspberry. When blackberry-raspberry hybrids are picked, it is not unusual for them to bring away the receptacle with the fruit, like a blackberry, if they are not quite ripe; and to leave the receptacle, like a raspberry, if entirely ripe. Few of Mr. Burbank's experiments have greater scientific interest than those in which the raspberry and blackberry have been hybridized.

be recalled, however, that the Primus was a first generation hybrid, whereas the Phenomenal appeared in the second generation, and the Paradox in the fourth.

There has been occasion in an earlier chapter to tell of hybridizing experiments in some respects even more curious, in which the raspberry was fertilized with pollen of the strawberry. These experiments will be further examined in a later chapter, with reference to the interpretation of the observed phenomena of hybridization of the various brambles.

But perhaps no comment could greatly add to the impressiveness of the simple recital of facts as to the production of new forms that, according to all botanical standards, should rank as distinct fixed species, through the purposeful blending, under the hand of the plant developer, of the germinal strains of the various blackberries and raspberries.

> *—The chances of obtaining results in plant improvement are directly proportionate to the number of experiments tried; and a hundred thousand experiments may be conducted as simply as a few.*

Designing A Strawberry to Bear the Year Around

And Other Work With Strawberries

A PLANT enthusiast was explaining the functions of plant life one day to that most appreciative and stimulative of all audiences, a company of school children.

He had told of the supreme importance of the *seed*--how Nature must first and foremost think of that, because it is the link between successive generations of plants; the only means of assuring a continuance of the race. To bring the illustration home, he had said that the seed is the very heart of the plant.

A little miss who had absorbed every word with the eager receptivity of the child mind looked up quickly as he finished and said:

"Then the strawberry is a plant that wears its heart on its sleeve, isn't it?"

It is only the imagination of children—or of the chance individual here and there who remains a

child all his life and whom therefore we term a poet—that can sound the depths of a great subject with a single phrase like that.

"The plant with its heart on its sleeve."

That is the strawberry. Cowering, timid, nestling among the grasses, seeking obscure corners, retiring as far as it may from observation—and wearing its heart on its sleeve!

The strawberry, it must be recalled, is own cousin to the peach and plum, the apple and pear, the rose, the blackberry, and the raspberry. But where these raise their heads into the air and hold out their flowers and fruit to the inspection of all the world, the strawberry has taken to earth and become a creeper.

Yet whereas the other fruits shield their seed always with pulp of the fruit, and some of them even enclose it also in armor plate shells, the strawberry puts its seed on the very outside of the fruit, where they will inevitably be eaten by any bird that so much as pecks at the fruit itself.

Hence the pertinency of the little girl's characterization.

The Odd Custom Explained

But, of course, there must be an adequate reason for the curious conduct of the strawberry.

A plant does not depart from the traditions of its ancestors and take on new and strange cus-

Its Heart on Its Sleeve

Mr. Burbank cites with approval the saying of a little girl who described the strawberry as the plant that wears its heart on its sleeve—a child's poetical way of citing the familiar fact that the strawberry fruit has the seeds on the outside. Mr. Burbank has experimented extensively with strawberries, and this specimen is a fair example of the results obtained.

toms unless it finds advantage in so doing. The case of the strawberry is no exception. That this plant is admirably adapted to its environment, and for that matter to environments of great diversity, is shown by the fact that strawberries of one species or another grow in regions as widely separated as Patagonia and Norway and Alaska.

And that the anomalous character of its fruit has very distinct advantages is evidenced by the fact that in all the diversified regions in which it grows the strawberry holds to precisely the same architectural scheme in the building of its fruit.

The leaves and stems and manner of growth of the different species may vary considerably, although even here there is no very wide diversity. But as to fruit, every strawberry of whatever species may be instantly recognized as a strawberry by the most casual observer. You may never have seen the species before but you could not possibly mistake the fruit for the fruit of any other tribe of plants.

A pulpy berry with tiny seeds sprinkled over it and only half imbedded in the pulp, like seed on the frosting of a cake, is a strawberry and nothing else.

Almost every other fruit has counterparts that suggest close relationship. Peaches and necta-

rines, apricots and plums, apples and quinces, oranges and grape fruit, lemons and limes, blackberries and raspberries, watermelons and muskmelons—these and sundry other fruits seem to go in pairs, as it were. They show the result of Nature's constant tendency to experiment and to find new ways of doing the same thing, each method reasonably well-adapted to its purpose.

But when the scheme of the strawberry had been perfected, it would seem that it must have proved so very admirable that there was little chance to improve upon it and no occasion to vary from it. Hence strawberries are quite in a class by themselves from the botanical standpoint, just as they are from the gastronomic standpoint.

In admitting this, it does not follow that we must agree with the enthusiast who declared, not long ago, that the strawberry is the one fruit that is past all improvement.

We shall urge in a moment that there is still a good deal to do before the strawberry can be considered a really perfect fruit from the standpoint of the consumer. It can be made, and should be made, to give up its seeds altogether, for example.

Now that it has come under man's protection, it does not need the seeds, any more than the pineapple and the banana need them.

Aforetime it placed the seeds on the very outside, where they would necessarily be eaten by any bird or animal that tasted the fruit, because it was imperative that the seeds should find means of transportation in order that the race of strawberries might spread and inhabit the earth.

The plant that cowers close to the ground cannot depend in the least degree on the wind or any other inanimate agency to transport its seeds. It must look to birds and animals to aid in this direction.

So the strawberry sprinkled its seeds on the outside of the fruit, having first taken the precaution to cover the inconspicuous seeds themselves with an altogether indigestible shell of cellulose.

The subterfuge served the little plant extremely well, as its wide range of wanderings and secure foothold in diverse soils and varied climates sufficiently attests.

The Seeds No Longer Needed

But now, as was said, this expedient is no longer necessary. Men will take good pains to see that the strawberry is abundantly propagated. And as such propagation may most advantageously be made through the agency of roots and runners rather than with the seed, there is no longer any necessity whatever that the seed should be retained. There are a good many scores of them

Hybrid Strawberries

These hybrid strawberries show the influence of wild progenitors in the form of the fruit. But all varieties of strawberries, and for that matter all species, are of remarkably uniform structure. No one could mistake a strawberry of any variety for a fruit of any other race.

on a single fruit; and the draft on the energies of the plant required to produce this large quantity of concentrated germinal matter must be very marked.

So when the strawberry has been induced to give up the seed-producing habit altogether, devoting its fruiting energy to the production of the juicy pulp of its unique product, the plant itself will advantage by the change, while at the same time gaining added favor with the fruit lover.

Not a great deal has hitherto been done toward relieving the strawberry of its seeds, because hitherto the plant developer has been concerned to increase the fruit itself and has given small thought to the seeds or has ignored them altogether.

But the briefest inspection of different strawberries will show that they differ a good deal as to relative abundance of seed; and there is no reason to doubt that the plant developer who undertakes this selective breeding with an eye to the preservation of plants that show a tendency to minimize the seed product, will gradually develop a race of seedless strawberries.

It appears to be quite the rule that plants habitually propagated by root division or by rooting stalks or runners tend to lose their power of seed production when long cultivated. The pine-

apple, the banana, the sugar cane, the horseradish, and the potato, have been previously referred to in this connection.

All of these, as is well known, are regularly propagated by the cultivator without the use of seed, and it is only under the most unusual conditions that any one of them nowadays produces seed at all.

I took occasion to emphasize this fact once in a lecture or an interview by saying that I would very willingly pay a thousand dollars an ounce for horseradish seed. The joke went the rounds of the papers and hundreds of people all over the country watched their horseradish plants the ensuing season with an idea to gaining the prize.

Needless to say no one has yet produced the ounce of seeds, or any fraction thereof.

Of course there are certain disadvantages that will attend the entire giving up of the habit of seed production.

It is not that the plant propagated exclusively from the roots or cuttings degenerates, as was once thought to be the case. In reality there seems to be no limit to the number of generations through which a plant thus propagated by division may maintain its original standards of quality. The familiar cases of the orchard fruits sufficiently support this belief. It may even be possible to

improve a plant slightly by selection when propagated solely in this way.

But, on the other hand, it is obvious that the plant that gives up the habit of seed production renounces the possibility of benefiting by the introduction of new strains through hybridizing—a process, as we have all along seen, that is the principal means through which plant evolution is brought about.

So, as regards the strawberry, it will be desirable to make sure that we have developed a fruit to approximate perfection before we induce it to give up the habit of seed production altogether.

It can hardly be claimed that the strawberry has reached this stage of development, notwithstanding the verdict of the enthusiast already quoted. But, on the other hand, it must be admitted that the best varieties of fruit approach an ideal standard rather closely. And when we recall that the development of these almost perfect varieties has taken place very rapidly and within comparatively recent times, it seems a fair conclusion that it will be possible to complete the perfection of the fruit in other directions in less time than it will take to remove the seeds.

So the plant experimenter who would undertake the task of eliminating the seeds from the strawberry need not hesitate for fear of succeed-

Plump and Delicious

The strawberry has been under cultivation for an indefinite period, but it is only in comparatively modern times that any such berries as those h e r e s h o w n have been grown. The ancients were doubtless content, and the moderns were also until a few generations ago, with a small berry not greatly superior to the ones that grow wild in many regions of America.

ing too soon. Unless Nature should produce a chance sport that is without seeds, or nearly so, somewhat like the nearly stoneless plum, the task of removing the seeds of the strawberry by mere selection would prove an arduous one.

Yet, as I said, it can doubtless be accomplished; and the game is thoroughly worth the candle.

Origin of the Cultivated Strawberry

Partly because all strawberries are so much alike, it has been unusually difficult to trace the origin of this fruit. But it is known that the modern varieties have been developed in a period of not more than two centuries.

The strawberry has indeed been under cultivation for an indefinite period. But the ancients were doubtless content, as we know that the moderns were until a few generations ago, with a small berry scarcely superior to the ones that grow wild in many regions of America. The systematic cultivation of the fruit began in England after new species of strawberry were introduced from North and South America.

But the really notable progress did not take place until the South American species known as *Fragaria Chiloensis* was introduced early in the eighteenth contury from Chili.

Nor indeed was there any immediate improvement from the introduction of this fruit. But

More Burbank Hybrids

In form and color these berries resemble pretty closely those shown in the preceding plate. They differ markedly, however, in flavor. Like the others, they are of mixed ancestry, blending the strains of berries from two hemispheres.

about the year 1760 a new variety suddenly appeared that was called the Pine strawberry because its fragrance suggested that of the pineapple. There was no record as to its origin, but the best authorities argue with good reason that it was a hybrid between the Chilian strawberry and the American species introduced much earlier from Virginia.

As usually happens when different species are hybridized, a tendency to variation was produced, and before the close of the eighteenth century there were two important types of new strawberry of the Pine variety, one of which was named by the botanist *Fragaria ananassa* and the other *Fragaria grandiflora.*

It is argued with plausibility that these are modified forms of the South American strawberry introduced from Chili, the precise share of other species in the combination not being perhaps clearly established.

The most popular modern varieties of strawberries are the descendants of this so-called Pine stock, the most notable impulse to the development of new varieties having been given through the introduction of Keen's seedling in England in 1821 and Hovey's seedling in America in 1837.

Subsequent development has come about through the usual method of crossing and selec-

Yet Another Hybrid Variety

Were it not for the marked difference in the leaves, one might think this bunch of berries of the same variety as the ones shown on the preceding plate. In point of fact they are very different, although of the same ancestral strain. They represent the segregation of characters in later generations, of which we have seen so many illustrations. But with the strawberry, the characters referred to concern the texture and flavor rather than form and exterior color.

tion. Of curse, many varieties, differing in such minor details as the production of runners, resistance to fungus attacks, and precise qualities of the fruit have been developed. Different races also show a diversity as to manner of flowering, certain varieties bearing pistillate flowers, just as the California dewberry does, whereas others bear perfect or bi-sexual flowers, as is customary with the members of the rose family in general.

But these are minor differences; and, as we have seen, the strawberry type in all its essentials has been marvelously maintained from first to last. Now as always this fruit is unique and curiously isolated.

Hybridizing Experiments

My own experiments with the strawberry have been carried out on a rather expansive scale, although I have given by no means as much attention to this fruit as to a good many others.

I have crossed all the familiar cultivated varieties, and in addition have made hybridizing experiments in which numerous wild species, some of them imported from distant regions, have had a share. I have, for example, commingled the strains of the best varieties of the cultivated strawberry with those of strawberries from Norway and from Alaska, and the native Chilian species, as well as with various wild species of our own.

The Patagonian Strawberry

There are some species of strawberry that are indigenous to Europe, but it is believed that the cultivated varieties did not attain real distinction until they were crossed with the species of South America, early in the 18th Century. Having this in mind, Mr. Burbank has sent to South America for strawberries to use in hybridizing experiments. The one here shown, the Patagonian, has been extensively utilized.

I have also attempted to hybridize a species from India, the *Fragaria Indica,* with other strawberries, but have been unsuccessful. It does not by any means follow that this cross cannot be effected. But it is perhaps not worth while to devote an undue amount of time to the experiment as the qualities of the Indian species are not such as make it certain a hybrid thus produced would have any value, except possibly as introducing a tendency to variation.

The Indian plant bears a small, insipid berry, and is cultivated for ornamental purposes only.

There are various wild strawberries growing along the Pacific Coast that offer interesting possibilities of hybridization. It is rather interesting to know that some of these are of the same type with the Chilian species that has already been named as the chief progenitor of the cultivated strawberry.

One of these, known as the sand strawberry, is quite common along the coast, especially in the northern part of California.

This is a plant with large, woolly leaves. It is greatly inclined to produce runners. It fruits sparingly, but the berries themselves are sweet and of fine flavor. There is great variation as to foliage and flowers, as well as in capacity for fruit production.

A Burbank Masterpiece

This splendid berry, a very mixed hybrid, represents the present culmination of Mr. Burbank's efforts in educating the strawberry. Many experts have pronounced this the finest berry that they have ever eaten. Perhaps no higher praise could be given it than to say it is quite as good as it looks.

The variation is best explained by assuming that this strawberry is itself a natural hybrid.

Another California strawberry that has interest is the wood strawberry, *Fragaria Californica,* a plant that usually has small leaves, rather upright in growth, and producing fruit abundantly, though the fruit itself is insipid and hardly worth gathering.

This plant also varies widely in different localities. In the Yosemite Valley I found a most astonishing variation in these as well as in other strawberries. Some of the wild varieties growing there were fully equal to the cultivated strawberry, while others were insignificant to the last degree.

Some of the plants grew strictly upright; others had leaves that hugged the ground and spread in all directions. There was a wide range of variation as to form, size, foliage and fruit. This was quite the most interesting group of strawberries that I have come across anywhere. But these plants do not seem to thrive in the valleys as they do in their mountain home.

As to the latter point, I have noticed a striking propensity on the part of certain strawberries to degenerate when placed under changed conditions of soil and climate.

We have seen that plums and many other plants are stimulated to exceptional growth by

A Stage of Development

In the course of his experiments, Mr. Burbank has worked extensively with several species of California strawberries. These show a very wide range of variation, growing in different territories, and give good opportunity for selection. As might be expected, combinations between these wildlings and the cultivated varieties often show great vigor of growth, and give the plant-developer the opportunity he is seeking.

precisely such a change. But when the promising wildlings from the Yosemite were transplanted to my gardens they ran to vines and produced very little fruit, although in their native habitat they had borne abundantly.

The experience was precisely the same with certain strawberries that were sent from Alaska, and from Norway, and in many of those from Chili. When the Alaskan vines came to me, they were fruited and they revealed an abundance of splendid berries. But under cultivation in my gardens they failed to thrive and such fruit as they produced was of inferior quality. The new soil and climate, which had proved such a stimulus to Japanese plums and New Zealand rhubarb and European daisies, and almost countless others, proved a handicap to the Alaskan strawberries. The new environment was not adapted to their constitution.

I have sometimes had the same experience with other plants, including certain varieties of currants, blueberries, huckleberries, and raspberries, as well as maples, beeches, hickories, and other trees from the eastern United States.

New Hybrid Varieties

But, of course, there are many other species and varieties that have shown no such antipathy to the conditions it had to offer, and I have produced

A Bed of Hybrids

Among the first things to look for in developing the strawberry are the size and strength of the plant itself, and the number of runners that it throws out. These will afford good indications of the inherent vigor of the plant, and enable the plant developer to prophesy as to its future, without waiting for fruiting time.

large numbers of crossbreed strawberries from various importations that have prospered.

In the course of the past forty years I have probably grown and fruited strawberry seedlings to the number of more than half a million; and among these have appeared some varieties that have had qualities of a high order, yet among them all I have not until somewhat recently secured one that was thought in all respects superior to some existing variety. Therefore, none of these were introduced. Ten or twelve years ago I had one that was nearly perfect but which proved to be a poor keeper and therefore not suitable for the market.

But more recently, as the strawberry strains became blended, a variety was produced which not only excels in quality but has the highly desirable characteristic of persistent bearing.

The new strawberry has been developed through hybridizing stock that had among its ancestors such well known varieties as Longworth's prolific, Brandywine, Monarch, and the Arizona Everbearing, and one or two varieties from Texas.

The later hybridizations, through which the perfected strawberry was finally secured, have involved crossing the Chilian strawberry with the white strawberry from Virgina and with the wild Pacific Coast strawberry.

The Experiment Progresses

In this strawberry bed, the weaklings have been thinned out, and only the largest and thriftiest plants remain to bear. The plant developer has utilized his knowledge of the correlation between foliage and fruit to good advantage, enabling him to save both time and space.

From these two lines of hybrids I have obtained the only seedlings that have been thought worthy of introduction.

The paragon of these is a plant of vigorous growth which makes just the right number of runners, and which has a healthy, thick, dark green foliage. The fruit is borne in clusters well up from the ground, and is delicious in quality, I confidently believe, beyond any strawberry before known.

This has been the universal verdict of those who have tasted the fruit of this complex hybrid. When John Burrows visited my garden, for example, he unhesitatingly pronounced this strawberry the finest in the world. So great was his enthusiasm that he wrote to eastern seedsmen, advising them to secure this strawberry, as everyone would soon be wanting it.

The fruit of this hybrid is not extraordinarily large, but it is firm in texture, of a fine crimson, and unlike most other strawberries it has a yellow flesh. Its lusciousness and deliciousness of flavor will give it a place apart even among the most select varieties of the fruit.

But quality of the fruit is not the only merit of the new hybrid. The plant has also, as just intimated, the singular and important quality of bearing fruit throughout the summer.

The main crop comes at the usual time for

strawberry ripening, but berries continue to ripen, even if less profusely, month after month.

Doubtless this habit of perpetual bearing is a trait brought out by the mingling of so many racial strains; in particular by the union of races from the two hemispheres. The summer of Chili is of course our winter. I have several times adverted to the confusion that seems to overtake many plants when brought to our northern latitudes from the southern hemisphere.

The case of some of the New Zealand apples, which were confused as to time of bearing for two or three years after being imported, will be recalled.

Also the case of the winter rhubarb, which came to be a perpetual bearer partly through the influence of such transplantation.

The new hybrid strawberry, which combines ancestral strains from the two hemispheres, furnishes another illustration of the tendency to retain ancestral habits as to time of fruiting, and thus, where parents from both hemispheres are involved, to develop among some of their seedlings a new habit of perpetual bearing.

It will probably be possible, by further selection from the new race of all-the-summer bearing strawberries, to extend their time of fruiting, as was done with the winter rhubarb, until they bear

throughout the year in any climate where the winters are sufficiently mild.

New Varieties in the Making

Other novelties that have developed among the progeny of the company of widely hybridized strawberries include constant producers and enormous producers that as yet lack some other quality which will presently be supplied.

I have also a white strawberry, grown from a variety that I grew in my childhood back in Massachusetts, and which was said to have come from Virginia.

By hybridizing this species a few promising white strawberries have been produced with new and delicious flavors. These are not yet quite as productive as could be wished. But second generation seedlings in great numbers are being raised, and interesting results are sure to be attained in the near future.

My strawberry stock, like my stock of plums and some other fruits, now consists of complex hybrids from which almost anything may be expected. At least it is certain that new combinations of qualities, within the extreme range of strawberry variation, will appear among the seedlings of these conglomerate yet carefully nurtured and selected stocks.

Summarizing my work on this fruit, I would

A Battalion of Seedlets

Those who are accustomed to setting out strawberry plants in tin cans will be glad to see Mr. Burbank's method of producing seedlets — although the tin-can method is quite right so far as it goes. As will be surmised from this picture, Mr. Burbank gives every seed its chance, but only a small proportion of the tiny seedlings shown in this picture will run the gauntlet of the first selection.

say that selections have been made almost altogether for flavor rather than for size and color. I thought that a good home strawberry that is tender, sweet, and of fair size rather than of exaggerated proportions, combining these qualities with the exquisite flavor of some of the wild berries, would be a distinct acquisition.

The varieties already in the market were many of them of enormous size, but for the most part they lacked flavor.

Anyone who has known the small wild strawberry at its best must always experience a certain disappointment in eating the cultivated varieties.

Moreover, most of our market strawberries are hard, being judged by the growers and the dealers by their shipping quality rather than by their flavor.

It seemed desirable, particularly for home use, to develop the strawberry for its appeal to the palate as well as to the eye; in other words, to restore to the fruit something of its pristine flavor, while retaining the good qualities introduced in recent times by selective breeding.

Such an endeavor to improve the flavor of the fruit, combined with the idea of all-the-year bearing and ultimately of seedlessness, may be said to suggest the lines of improvement along which the plant developer of the immediate future should

An All-Summer Bearer

This is Mr. Burbank's new strawberry which blossoms and bears all summer, and which forms the basis of his hope to produce an all-the-year-round bearer in warm climates. This tendency to bear continuously probably results from the blending of the heredities of species from the Northern and Southern hemispheres.

work in perfecting the strawberry. But the production of the seedless strawberry, as already pointed out, must be the final stage of the process of development. When the seeds are gone, there will obviously be no further opportunity for improvement by selective breeding, with or without hybridization. But long before the seeds are bred out, we shall doubtless have many varieties of strawberries that approach perfection as to all other desirable qualities.

—Nature has done much for the luscious strawberry, but there is still as much or more for us to do.

The Sunberry—A Production From the Wild

A New Food Plant From A Poisonous Family

SUPPOSE that you had been trying for twenty-five years to effect a certain purpose—say the cross-pollenizing of a particular pair of species of plant.

Suppose that year by year your efforts had met with total failure; but that finally, just as you were on the point of giving the matter up as hopeless, you were to attain success.

Doubtless under these circumstances you would be somewhat elated over your achievement.

Suppose, then, further, that the plant that grew from this hybridization, achieved with such infinite difficulty, proved a producer of valuable fruit. Suppose that the fruit met with almost immediate recognition, and that the plant was widely introduced and attained exceptional popularity.

And then, finally, suppose that some one should come along and decry the fruit, not because of its

lack of merit, but because the parent plants from which the hybrids grew belonged to a family of poisonous plants.

Suppose the hue and cry thus raised should be given an element of plausibility by the fact that some unscrupulous person had sold to gardeners a plant of a different species from either of the parents of your hybrid, yet of an allied race, and had claimed that this plant, which bears a fruit of doubtful edibility, is identical with the one you had introduced.

Suppose all this, I say, and then try to imagine just what would be your attitude of mind toward the work you had accomplished on one hand, and the persons who—not always for the best motives or without prejudice—were its traducers.

The Sunberry and Its Critics

In suggesting this I am only asking you to put yourself in my place and imagine what must be my natural attitude of mind toward one of the most celebrated, and without doubt the most berated, of all my plant productions—the fruit which I named the Sunberry, and which the dealer to whom I sold it rechristened—without my consent and much against my wishes—the "Wonderberry."

For the supposititious case that I have just outlined really summarizes the facts as to the production and introduction and traduction of that fruit.

ON THE SUNBERRY

The Sunberry, far from being merely a familiar form of *Solanum* introduced under a new name, as some ignorant and misguided critics have alleged, is in reality the product of one of the longest and most persistent series of experimental hybridizations, culminating in the blending of two specific plant strains that had seemed to be antagonistic beyond the possibility of amalgamation.

The parent plants themselves, though they no doubt belonged to a poison-bearing family, were not in themselves poisonous. And the fruit of their hybrid progeny is not only palatable in high degree, but altogether wholesome, as hundreds who have eaten it habitually could testify.

Let me quote a paragraph from a letter recently received, by way of substantiation, and then let me turn from this controversial aspect of the subject to consider the story of the Sunberry itself:

"I have grown the Sunberry for the past three years," says a college professor who is an amateur gardener. "We have used the berries for sauce, cobbler, and pies—principally for pies. Some were eaten raw from the vines. For me the pie is the one great way to use the berry. Without exception I place a Sunberry pie at the head of the pie list, and I do this with a full appreciation of the excellence of cherry pie, apple pie, pumpkin pie, mince pie, berry pie, etc.

"I think it hardly does the Sunberry pie justice to compare it to blueberry pie. They have much in common, but the Sunberry is richer.

"I have never kept account of the yield, nor tried for a large yield. I have a small strip of ground, eight by sixty-five feet, which gave us a pie each day from early in August until frost, usually about November 1st, and left us a surplus of forty to fifty quarts to can for winter use."

So much for the fruit itself. Then touching on the other aspect of the subject, the writer continues:

"There has been much criticism here, some of it the most senseless stuff I ever heard outside of an asylum, and most of the extreme criticism by those who never grew the plant. One man, an attorney, planted some Sunberries and pulled them up because they looked like nightshade. I completely converted him by sending him a pie."

In conclusion, the writer goes to the heart of the matter when he says: "I think much of this criticism was originally due to some very unfair articles that got copied and were thus spread somewhat generally. As far as I can judge, the original article was written out of pure malice. I can account for it in no other way."

These quotations will perhaps serve sufficiently to suggest the quality of the Sunberry, and to sug-

Sunberries

This is in some respects one of the most remarkable, and unquestionably the most maligned, of fruits. It resulted from a hybridization of two Solanums effected after years of unsuccessful efforts. It was named Sunberry by Mr. Burbank, but was subsequently re-christened the Wonderberry, quite against his will, by the dealer who purchased and introduced it. It has been fiercely assailed, largely because it was confounded with quite a different species of Solanum; notwithstanding which it has made its way in the fruit-garden, and is destined to be much more popular in the future than it has been hitherto.

gest also the animus of the criticism that has been directed against it. It seemed necessary to advert to this aspect of the matter because a fair proportion of the people who have heard of the "Wonderberry" at all have heard only words of condemnation.

Moreover a large proportion of the people who think they have seen or grown this fruit have in reality never seen it.

Whoever supposes that the true "Wonderberry," or Sunberry as I still prefer to call it, is identical with the ordinary nightshade is laboring under an illusion that might readily be dispelled by inspection of the respective plants themselves.

And whoever doubts that the true Sunberry is an appetizing fruit and a valuable addition to the list of table berries might readily be convinced, had he some neighbor to make the demonstration suggested by our correspondent, through sending him a Sunberry pie.

But let us forget all controversial aspects of the subject and make inquiry as to the origin of the new fruit.

The Nightshade Family

I have elsewhere referred to my interest in the members of the nightshade family, or, as the botanist calls them, the *Solanaceae*.

The fact that the potato, with which my first

experiments in plant development were made, belongs to this family would naturally give me an interest in the tribe. But I was particularly attracted also because of the diversity of characteristics among the members of the family.

Here, on one hand, are the potato, the tomato, and the eggplant, ranking among our highly important garden vegetables, and the strawberry-tomato or ground cherry among the minor vegetables that have a good share of popularity; and, on the other hand, closely related species are bearers of the most powerful narcotic poisons, including belladonna and hyoscyamus, drugs that have an accepted place in the pharmacopoeia.

Add that the tobacco plant is another member of the family, and it is clear that this is one of the most curiously versatile, and, from a human standpoint, one of the most important plant tribes.

My interest in the family extended beyond the familiar plants just named, and included several species of nightshade that are chiefly known as roadside weeds and bearers of berries some of which are eaten on occasion by country folk, but which in the main have a bad reputation, some of them being accounted highly poisonous.

The name "deadly nightshade," applied to one of the most familiar species, suggests the repute in which these weeds are commonly held.

Yet it is known to the residents of some country districts, particularly in the Mississippi Valley, that the little black berries of the nightshade, if thoroughly ripe, may be made into pies and eaten with at least relative impunity. It is only in lieu of any fruit of more acceptable character that any one would be likely to make the experiment, however, as the distant relationship of the plant to the deadly nightshade, *Atropa belladonna,* and the henbane, *Hyoscyamus niger,* from which well-known poisonous drugs are obtained, is at least vaguely recognized, and the plants are very generally held under suspicion.

Nevertheless the potato, the tomato, and the eggplant may be cited as affording a convincing demonstration that there is merit in the family, even though one were to dispute that the tobacco could legitimately be put in evidence in the same connection. And, for me at any rate, there was interest in the knowledge that at least two species of *Solanum* were available for experimental purposes that were hardly under suspicion as to the production of poisonous fruit, however lacking in attractive qualities their products might be.

Progenitors of the Sunberry

One of the nightshades in question is a rather large plant known botanically as *Solanum guinense,* which found its original home in Africa,

A Sister of the Sunberry

These little seedlings are the result of a cross made between the Solanum Guinese and the Solanum nigrum. One of the parents, therefore, is a parent of the sunberry, the other being a related species. It is as yet too early to say just what possibilities of development this new hybrid holds.

but which has been known for a generation or so in this country, and is sometimes referred to as the "garden huckleberry."

The other is a smaller species, known as *Solanum villosum,* which was indigenous to Europe, but which is said to have been accidentally introduced in this country a good many years ago from seed mixed in the ballast of a ship. This chanced to be thrown out where it had opportunity to establish itself, near Philadelphia; from which region, after the manner of wandering weeds, it found its way across the country.

The African plant is a strong and heavily fruiting shrub, growing about two feet high on good soil, and spreading to be about three feet in diameter.

It produces large black berries in clusters that stand upright, and that, in the case of some varieties, are nearly as large as cherries. The fruit is not unattractive in appearance, and, as already noted, attempts have been made to introduce it as the "garden huckleberry." But such attempts have met with small measure of success for the very excellent reason that the berry is practically inedible.

I have tested it often, and have always found that one berry is more than any person is willing to eat.

ON THE SUNBERRY

I have never known a person who could be induced the second time to attempt to eat this so-called "garden huckleberry," the taste being villainous.

The plant is indeed somewhat closely related to the black nightshade, *Solanum nigrum,* the American species that is common everywhere, one form of which, known as the stubble-berry, is said to be poisonous, especially if eaten by children, in large quantities when not fully ripe, although fairly palatable when cooked.

The stubble-berry in one or another of its varieties has been used for cooking, in all countries where it grows, when fruit is scarce, chiefly to make pies, as well as for canning. But it is necessary to have the fruit fully ripen; which is often accomplished in cold climates by spreading the berries thinly on shelves and allowing them to mature slowly.

In some regions, as in the Dakotas, the bushes are pulled and hung in the cellar, the fruit being used from time to time as it ripens.

In France the young shoots of this plant are used as a green vegetable, and the plant is even advertised in French catalogs.

The "garden huckleberry," however, differs considerably from the ordinary French stubble-berry, the fruit being much larger in size but far

inferior in flavor. It is, however, more nearly free from poisonous qualities, notwithstanding its vile taste.

The differences between the plants themselves are marked, the *Solanum guinense* being, as already noted, a rather heavy shrub, while *Solanum nigrum,* though varying considerably, is usually a low spreading and slender plant. It may be said, however, that both of these species, like most other members of the family, show a strong propensity to vary. The black nightshade in particular takes a great variety of forms according to soil and other conditions; each locality having its own variety differing in minor respects from plants of other regions.

I have gone somewhat into detail in this matter, because I wished to establish clearly the standing of the *Solanum guinense* that was used in my hybridizing experiments, and which thus became one of the parents of the Sunberry; and in particular I wished to make clear that this is a species differing considerably from the better known black nightshade, *Solanum nigrum,* with which it has been confounded.

The other parent of the Sunberry, already named as *Solanum villosum,* is a plant differing conspicuously from either of those just described. It is low, and tends to a spreading growth a few

Sunberry Plant

This picture shows the method of cultivating the sunberry. It thrives in almost any soil, and, curiously enough, it seems to do rather better where it is somewhat neglected than where too highly cultivated; perhaps a reminiscence of the characteristics of the sunberry's half-wild parents.

inches above the ground, never growing upright. The foliage of the plant is pubescent or downy, accounting for its scientific name. In this regard also it is quite different from *Solanum nigrum* and *Solanum guinense.*

The fruit grows in clusters of five berries that droop characteristically and always remain greenish in color even when ripe, whereas the fruit of most other *Solanums* turns black on maturing.

The berries are borne abundantly, and like the tissues of the plant itself they are free from poisonous qualities. The wholesome nature of the plant is attested by the fact that it is eaten freely by herbivorous animals wherever it grows. Rabbits, cattle, and pigs eat it with avidity.

Producing the Sunberry

I have already referred to the long series of fertilizing experiments through which I endeavored to cross the various *Solanums.*

I may add that Professor Hansen, of North Dakota, has also been interested in crossing the two fruiting *Solanums* of which we are speaking, and from which the Sunberry was ultimately produced. But his efforts at hybridizing these species were unsuccessful.

These details are mentioned to emphasize the fact that the production of the Sunberry—although, as will appear in a moment, it came about

ultimately as the result of a single successful experiment—was by no means a task to be accomplished offhand by the first person who chose to place pollen of one flower on the pistil of the other. I did this season after season, seemingly with no effect whatever.

At last, however, in the season of 1905, after I had more than once half decided to relinquish the effort to hybridize these plants, my perseverance was rewarded.

I had cross-pollenized the great African stubble-berry, *Solanum guinense,* and the little downy nightshade, *Solanum villosum,* as I had done many times before, with no change or added detail of method, and for the moment I had no reason to suppose that the efforts had been more successful than before.

But when the seeds were sprouted in the greenhouse, a certain number of plants were discovered that differed from any I had seen before.

These plants were of a new type, and as they developed it became increasingly clear that they represented almost an exact compromise between the two parent species.

There could be no question that they were the hybrids I was seeking.

But the appearance of these hybrids was such as to corroborate the belief, founded on my long

series of unsuccessful hybridizing experiments, that the two *Solanums* I had finally mated were so widely different in constitution as to stand at the very limits of affinity within which crossbreeding is possible.

We have discussed a number of instances in which similar crosses have been made between species widely separated. Such, for example, was the cross between the California dewberry and the Siberian raspberry, which produced the Primus berry; also that between the dewberry and the Cuthbert raspberry, which produced the Phenomenal berry; and that between the plum and the apricot, which produced the Plumcot.

In each of these cases, it will be recalled, the hybrid showing intermediate characteristics between its parents, constituting virtually a new species, and proving its individuality by breeding true to type from the seed.

It was rather to be expected, then, that the hybrid *Solanum* would similarly prove its individuality, and the expectation was fully realized.

As the plants came to maturity, one bloomed but failed to produce fruit. The others, however, fruited quite abundantly, some of them profusely.

The fruit was intermediate in size between the fruits of the parent plants. Its quality was entirely different from that of either parent. It had

A Relative of the Sunberry

These are blossoms of a South American plant, the Solanum jasminoides, sometimes called the potato plant. The blossoms of this plant closely resemble those of the sunberry, although the plants are very far from identical in other regards. The relationship between the two is not very close, but the similarity of blossom gives another illustration of the way in which a character may be transmitted and modified into different strains of plants from a different ancestor.

something of the flavor of the blueberry or huckleberry of the East, and was especially delicious when cooked.

It differed as widely as possible from the vile-tasting fruit of one parent and from the insipid, tasteless fruit of the other.

It should be explained that there were only about twenty of these hybrid plants in a large colony of seedlings. The remaining members of the company were precisely similar to the mother plant on which they grew—this being the small, downy species, *Solanum villosum*—thus showing that they were not hybrids. It is probable that there was only a single fruit that had been hybridized, although the foreign pollen had been applied to many pistils.

The entire company of new hybrid *Solanums* were probably produced from the seeds of a single berry, the other berries having been quite unaffected by the attempt at cross-pollenizing.

But it sufficed to have produced a score or so of hybrids; I should have been delighted with a single one, after all these years of waiting.

New Species

Naturally I selected the best two or three individuals among the twenty hybrids—the ones excelling as to profusion, size, and flavor of berries.

The seeds of these plants were carefully saved,

and next season there grew from them a crop of plants precisely like the parents. The progeny of the hybrids followed their parents more closely than the unhybridized offspring of either of the *Solanums* used in the original cross usually do.

As already noted, all species of wild *Solanums* tend to vary, but the new species reproduced itself exactly, except that a very slight difference in the flavor of the berries was barely perceptible.

As two crops of these plants could be raised in a season, they were multiplied rapidly, and there was astonishingly little variation in the size, quality, or growth of the bushes. Without exception the plants resembled the original hybrid, and differed radically from either parent of that hybrid.

It was obvious, therefore, that a new and fixed species of *Solanum* had been evolved through the hybridizing experiment. As the reader already knows, the new plant was christened the Sunberry.

The unwarranted change of the name from Sunberry, the only name I ever authorized or approved for the plant, to "Wonderberry", and the mis-statements that have gained currency regarding the origin of the plant and the characteristics of its fruit have been sufficiently referred to.

The true qualities of the fruit itself have also

been revealed through a quotation from one of the many amateur gardeners who have grown it in successive seasons and found it a valuable addition to the list of garden fruits.

It may be added, however, that the Sunberry makes particular appeal because it ripens late in the season, after most other berries have ceased to bear. It is well to note, also, that the plant shows the hardiness and thrift and vitality usual with hybrids, and will often grow to better advantage on a poor soil and without much cultivation than when especial attention is given it. In most regions, to water it is a mistake, and to fertilize the soil for it an even greater one—making the blossoms drop.

In a word, it is a plant that resents too much petting. It retains something of the character of its wild ancestors.

As to inherent constitution, the Sunberry is a perennial, but it may best be grown annually from seed, quite as its relative the tomato is grown, although that plant also can live from year to year in the proper climate.

As already stated, it grows true from seed year after year, proving thus its specific individuality, and differing not alone from hybrids in general but from the greater number of our cultivated fruits.

A Branch of Sunberries

This picture reveals the profuseness of bearing of the sunberry, and also suggests the similarity of the fruit to the blueberry. The sunberry is perhaps at its best when made into a pie. "Without exception," writes an enthusiast who had very fully tested the fruit, "I place a sunberry pie at the head of the pie list, and I do this with a full appreciation of the merits of the apple pie, cherry pie, pumpkin pie, mince pie, and berry pie."

The Sunberry has unexpectedly been found adapted to cold northern climates. In the Alberta country, in the latitude of northern Alaska, the Sunberry is highly appreciated, especially as it is about the only berry that can be raised where the thermometer often goes to 40 or even to 60 degrees below zero.

Varying Traits of Hybrids

From the standpoint of the gardener, the Sunberry has importance as a notable addition to the list of small fruits.

From the standpoint of the plant developer it may be said to have perhaps greater importance as illustrating the possibilities of the development of new species by hybridization—species markedly different from, and in many ways superior to, those from which they spring.

It is true that other experiments have been detailed that illustrate the production of new forms of plant life through hybridizing already existing ones. A few paragraphs back several of these were named—the Primus berry, the Phenomenal berry, and the Plumcot. But in the case of these fruits, it will be recalled, the parent forms were one or both bearers of valuable fruits. The hybrid plants improved upon their parents, but did not show entire departure from the traditions of the races from which they sprang.

But the Sunberry, as we have seen, sprang from parent forms neither of which produced edible fruit.

This was a union of two racial forms that were separated almost to the point of permanent segregation. The combination of hereditary factors of two distinct species from two hemispheres developed a hybrid that differed very widely from either parent. As it chanced, this hybrid had qualities of fruit that gave it a new appeal and a standing, from the viewpoint of man, quite different from that accorded either of its parents.

The case, then, of the Sunberry emphasizes anew the principle that new species may be produced through hybridization, and that, provided the parents are genetically separated just widely enough, their offspring may show such a blending of characters as to constitute a new form, and to be able to transmit these characters to its progeny in such a way as to meet the test by which species are everywhere recognized.

We have seen that there is possibility of hybridization between forms that are a shade more widely separated, in which case the hybrid offspring have the appearance of new species, but lack fertility. Such instances were presented in the hybrid colony of offspring of the dewberry fertilized by pollen from the apple and pear and

mountain-ash and rose; also by the hybrid between strawberry and raspberry.

These strange hybrids would clearly enough have been entitled to recognition as new species had they been able to reproduce themselves. But their sterility reduced them to the rank of mules—to make comparison with the most familiar instance of an infertile hybrid in the animal world.

From these sterile hybrids the Sunberry differs fundamentally in that it is if anything more prolific than either of its parents.

Meantime the Sunberry differs from the hybrids of another and more familiar type that arise from the union of parents that are so closely related that cross-pollenizing is easily effected between them. Such hybrids, of which we have seen many examples—crosses between the different daisies, between black and white blackberries, thorny and thornless briers, stone-seed and stoneless plums, and sundry others—follow, as we know, a characteristic line of development. The hybrids of the first generation resemble one parent more than the other. The hybrids of the second generation show wide variation, some of them reverting to one ancestral strain and some to the other, the characteristics of each strain being variously segregated and recombined.

Nothing like the direct and complete reproduc-

A Brazilian Solanum

This distant relative of the sunberry—related also to the potato and the tomato—has been sent to Mr. Burbank from South America, in the hope that its thorn might be removed. It is now undergoing training in Mr. Burbank's garden at Santa Rosa. Note the web-like effect of the leaves in relation to the main stalk and the smaller stems.

tion of the characteristics of the hybrid in its offspring, as shown by the Sunberry, is manifested in the case of these familiar hybrid forms that spring from the union of closely related species or varieties.

What the Sunberry Teaches

All this should be borne in mind by anyone who is prone to reduce the principles of heredity to formulae of undue simplicity.

The new formulae of the Mendelians, for example, which have such admirable application to many cases of the crossing of related forms—where particular unit characters are segregated and recombined—have no application, or to be applied must be distorted from their original implications, in dealing with such a case as that of the Sunberry.

Here there is no clear balancing of dominant and recessive factors, with the overwhelming presentation of the dominant factor in the first generation and the reappearance of the recessive factor, beautifully segregated, in the second.

Instances of inheritance of that order we have had presented again and again. We shall hear of more of them before we are through.

But, in the meantime, let us not forget the lesson taught by the Sunberry—let us recognize that there are conditions of hybridization under

A Million Solanums on Trial

This is the South American species shown in the preceding picture. Its fruit is edible, but is made almost inaccessible by the spine. The bed back of Mr. Burbank's house, as shown above, represents a number of second-generation seedlings, from which, it is hoped, specimens may be selected that will prepare the way for a future spineless variety, as well as a great improvement in the fruit. It was through operations conducted on such a scale as this that the sunberry was produced.

which characters appear to be permanently blended when first brought together; not momentarily linked in an unequal union to be segregated in the next generation, but fixed in a new and lasting combination that strikes a balance between the combinations presented by the parent forms.

It is possible, to be sure, to interpret this aspect of heredity in Mendelian terms. Nor should we deny altogether the validity of such application, for we may well believe that there are gradations all along the line, could we search them out, between the case of the sterile hybrid, born of widely diverged parents, and the case of offspring of members of the same species that differ only as to some varietal character.

Of course the same laws, could we fathom them in their broader aspect, apply to each and every case.

But, on the other hand, it is at least open to question whether it would not be better to reserve the application of the Mendelian terms to such types of inheritance as Mendel himself studied, in which there was interplay of dominant and recessive factors, and the varied segregation of the different factors in new combination in the second filial generation.

Thus restricted, the Mendelian formula has individuality and specific meaning.

There is danger that it may lose such individuality and such specific meaning, and with these a large measure of its real value and importance, if the propensity of some present day enthusiasts to make the words Mendelism and Heredity synonymous is generally followed.

Be all that as it may, at least we hazard nothing in saying that the case of the hybrid Sunberry, sprung at a bound into existence as a full-fledged species, is of compelling interest to the student of heredity, from whatever aspect he may view the subject.

—Whatever else may be said of the Sunberry, for or against, the fact remains that it was a successful union of two racial forms that were separated almost to the point of permanent segregation.

The Utah Currant

The familiar cultivated currant is the descendant of a wild species that was found in both Europe and America. A good many other species are found in various parts of the world, and Mr. Burbank has utilized several in crossbreeding experiments. Among these is the Utah currant, here shown, a native of Western America.

A Dozen
Other Delightful Berries

Offering Encouragement to Combine and Build

IN the ensuing chapter will be brought together for brief consideration the records of investigations having to do with a varied company of berries, some of them among our most familiar garden fruits, others practically unknown to anyone but the specialist.

It must not be inferred that these berries lack importance because they are grouped here together instead of being given individual chapters.

It is only necessary to name the currant, the gooseberry, the huckleberry and blueberry, and the cranberry as members of the list to give assurance that the fruits under consideration have considerable economic importance. But it chances that my work with these fruits, and the others listed with them for present consideration, has been somewhat less extensive than with the small fruits already described.

So much remains to be told concerning the plants with which more notable developments have been achieved, that it seems best to conserve space by treating the fruits that are now under consideration somewhat summarily.

It will appear, however, that the amount of work done in connection with these various fruits is by no means inconsiderable; and that in more than one instance results have been attained that would warrant more extended consideration were it not that they must be viewed in a relative scale.

Let us then somewhat briefly run over the list of a number of interesting fruits that fully justify the title under which they are classified in the present chapter, yet which have associated with them no story quite so spectacular as some others that have been reviewed in recent pages.

We may first recall a few less conspicuous members of the great Rubus family—the brambles. The more notable members of this remarkable family have been dealt with at length. But we cannot take leave of so notable a group without at least incidental reference to a few other members of the tribe that have shown interesting possibilities of development.

One of the most interesting among these minor Rubuses is the western raspberry, a wild black species, known to the botanist as *Rubus leucoder-*

Wild Oregon Currant

This is another of the wild species of currant growing along the Pacific Coast, and one that gives promise of value as a hybridizing agent. Even in the wild state, as here shown, it bears fruit of a good size, and of fair quality.

mis. This plant, as its Latin name suggests, has a white stem. As to fruit, it rather closely resembles the eastern black raspberry which is a parent of our cultivated blackcap. It is a strong, vigorous grower, producing stout upright canes and berries that are unusually sweet and of a pleasing flavor.

Several years ago, while in the Eel River region in Humboldt County in California, I discovered many excellent plants of this western blackcap of specially vigorous growth, and producing berries of extra size and quality. A large number of berries were gathered from the most promising plants, and their seeds carefully planted.

After several years of planting and selecting, a promising berry was produced, fully as good, I think, as most eastern blackcaps and much larger than any then known. Unfortunately, the stem and backs of the leaves of the plant are covered with long, sharp prickles, and these are so annoying in cultivating or picking the fruit that it seems not worth while to introduce a plant thus handicapped.

There is opportunity, however, to do away with these prickles through hybridizing and selective breeding along the lines already fully detailed in the account of the thornless blackberry in an earlier chapter of the present volume. When this has been done, the developed variety of the west-

ern blackcap will be worthy of a place in the small-fruit garden side by side with the very best varieties of raspberry under cultivation.

It should be added that this species, like a number of the eastern Rubuses occasionally produces nearly white berries. These also might be developed into fruits of real merit, and doubtless will be when someone finds the time and interest to carry out the experiment of developing them along the now familiar lines outlined herein.

The Cape Raspberry

One of the strangest forms of Rubus with which I have experimented is a species that came to me from New Zealand but which had its original home in Southern Africa.

This form is known as *Rubus capensis,* in recognition, presumably, of its having been found in the Cape region of Southern Africa. It is not confined to this region, however, as it is believed to be the same species described by Stanley as growing in various regions in the heart of the Dark Continent.

The fruit borne by the Cape raspberry is of a dark mulberry color. It is of the raspberry type quite unmistakably but is larger than any other raspberry I have ever seen. The quality of the fruit is fair, and its large size makes it peculiarly attractive.

The foliage of the plant is peculiar, having a curious resemblance to leaves of the grape. Indeed the resemblance is so striking that people passing it at a little distance have often asked what kind of a grape I had that grew upright like a bush.

The entire plant is highly ornamental, growing about four feet in height and bearing its handsome, large, leathery leaves in profusion. The prickles on the leaves grow so close together and are of such texture that they scarcely injure the skin in handling them.

The plant is not very hardy, but its other qualities make it a very desirable species for hybridizing experiments. Indeed, I know of no wild species of Rubus in the world that gives more promise of being useful. My own experiments with the plant were not carried far enough to produce particularly notable results. But the plant invites attention from anyone who is interested in the further development of our small fruits. Coming from the Southern Hemisphere, it should introduce a tendency to variability in a conspicuous degree when crossed with some of our northern species.

Among other good qualities of the hybrid progeny, there should be a tendency to prolonged bearing, such as we have seen in the case of the

South American Currants

Attention has been called repeatedly to the large use that Mr. Burbank makes of the South American plants in his hybridizing experiments. The currant furnishes still another illustration. It is fruit that is of no great value in itself, but no one can predict what possibilities it may reveal when hybridized.

strawberry produced by the crossing of species from the two hemispheres.

The Salmon Berry

Another very interesting Rubus that shows great possibility of development is the native species familiar along the Pacific Coast from Central California to Alaska known as the Salmon berry, *Rubus spectabilis.*

This is a tall, erect bush, with stout, perennial canes. The stalks are usually sparsely clothed with weak, slender prickles, but are sometimes nearly smooth. The flowers are borne singly and in pairs on slender stalks; they are large and showy, being bright red or purple.

In Humboldt and Mendocino Counties, California, I have seen this berry growing in the pastures where it became a genuine tree from twelve to fifteen feet in height, some of the stalks being two or three inches thick. It is reported sometimes to grow six inches in diameter. The cattle in the pastures browse on the plants as high as they can reach, and the berries are gathered with a step-ladder or more commonly from the back of a horse.

The berries themselves are large and soft, almost falling to pieces in the picking. They are unusually juicy, and with almost no acidity.

There are two strongly marked varieties of

Fruit of the Flowering Currant

There are several species of currant, that, owing to their rather exceptional flowers, are popularly designated as "flowering currants." Some of these grow wild in the Rocky Mountain regions, others along the Pacific Slope. In the wild species, the fruit is usually not of a high order, but in one case at least this has proved capable of great development through selective breeding. In general, the wild currants are worthy of more attention than they receive from the fruit developer.

Salmon berry. One has the pale yellow fruit, the other reddish, varying to dark crimson. These two varieties may be seen growing side by side, in some instances without intermingling, each individual bush producing berries of one distinct quality and color.

The Salmon berry requires a damp, cool atmosphere and moist soil. When transplanted into the warm valleys it does not thrive. There chances to be a moist piece of sandy land on my Sebastopol farm, however, where it thrives fairly well. Here we have grown the Salmon berries from Alaska, Washington, Oregon, Northern Minnesota, and various parts of northern and central California for more than twenty years.

Among these I have noticed considerable variation in the size and color of both fruit and flowers. My experiments, however, have not been carried out extensively, partly because of the difficulty that attends the growing of the Salmon berry in this locality. But I have gone far enough to make me confident that the fruit is worthy of further development, although I shall probably leave the task for someone who is more favorably situated geographically for the cultivation of this particular fruit.

The Japanese Golden Mayberry

We have already learned that the Rubuses are

Fruit of the Mayberry

The Mayberry came to Mr. Burbank as a wild plant from Japan, bearing a fruit of small value. It proved responsive to the plant-developer's efforts and ultimately developed a fruit that was christened the Japanese Golden Mayberry.

cosmopolites. The facility with which the seeds of the bramble berries of various kinds are distributed by the birds doubtless accounts in part at least for the wide migrations of the tribe, and this in turn accounts for the great range of variation among the different species.

In the course of my experiments with the family, I naturally enough looked to Japan to supply material, just as in the case of so many other tribes of plants. The species that I received from there certainly did not appear to be an encouraging plant to work upon. Yet it proved susceptible of development, and well repaid the efforts bestowed upon it.

The plant in question was found growing wild high up on the sides of Mt. Fujiyama in Japan. It is known botanically as the *Rubus palmatus*. The collector who secured it for me sent the best specimens of the fruit that he could find, and roots of the plant itself. The plants that grew from these roots bore large, white blossoms, solitary and drooping on long, slender stems swinging from the leaf axils.

But the berries were a great disappointment, being small and of a dingy, yellowish, unappetizing brown color.

Their flavor was as unattractive as their appearance.

Canes of the Mayberry

The Japanese Mayberry is still undergoing development in Mr. Burbank's garden. Among other things, an attempt is being made to remove the thorns from the stems. Partial success has been attained, as these pictures illustrate. The tendency to variation here shown suggests indefinite possibilities of further improvement.

Knowing the possibilities that lie in the hybridisation of Oriental species with their American relatives, however, I did not despair of the Mayberry, but hybridised it with the Cuthbert raspberry, a plant that proved a remarkable parent, as will be recalled, in connection with other hybridising experiments—notably the production of the Phenomenal berry.

The hybridisation was effected without difficulty, and the progeny showed a tendency to rapid improvement. After a few generations, the berries were greatly enlarged, and took on a bright yellow color instead of the original dingy brown. The improvement in quality was also very appreciable.

But what was perhaps most notable was the extreme earliness with which the hybrid plants fruited. It was, indeed, the early bearing habit of this Rubus that stimulated me to make the cross. It proved possible to retain and accentuate this habit while introducing the Cuthbert quality into the berries. The result was a new type of berry, as large as the Cuthbert raspberry, ripening in April, a month before the Hansell, a variety then famed for its early fruiting.

Indeed the hybrid Rubus bears fruit at a time when the earliest of the standard raspberries have hardly awakened from their winter rest.

This habit of early bearing combined with the

unusual qualities of the berry itself seemed to justify its introduction. So it was announced to the public in 1893 as the Japanese Golden Mayberry.

The bushes on which the Mayberry grows are distinct from all others of the tribe, attaining a height of six or eight feet and being almost tree-like in form. All along the branches the white, bell-shaped blossoms are pendant, soon succeeded by the large, sweet, golden, semi-translucent berries.

The plants do not at first bear very heavily, but as they advance in age they produce a surprising abundance of fruit.

Unfortunately the hybrid Mayberry is not hardy, and so is not adapted to the climate in many parts of the United States. It has become almost the standard berry in the Philippine Islands, and it is sure to gain popularity in any climate to which it is adapted.

More recently I have given attention to improving the variety, and the developed races bear luscious fruit fully an inch and a half in diameter. The fruit is rather soft and more suitable for home use than for the market. But it is a productive and delicious berry, well worthy of introduction in all milder climates.

Possibly a series of hybridizing experiments,

introducing some northern species of Rubus, would result in giving the plant hardiness, in which case it should become popular everywhere. Such a line of experiment is well worth undertaking.

The Cloudberry

In marked contrast to the Mayberry in point of habitat and hardiness is the Rubus from the far North that is commonly known as the Cloudberry, or, in some regions, the bake-apple berry, and known to the botanist as the *Rubus chamemorus*, a name given to it more than a century and a half ago by Linnaeus.

The plant inhabits the peat bogs and similar localities far to the North, even within the Arctic Circle. Like many other arctic species of plants it does not confine its habitat to a single continent but is found in northern Europe and Asia as well as in North America. The same thing is true of Arctic species of birds and animals; the obvious explanation being that it is easy to wander from one longitude to another in the regions where all longitudes merge toward a common center.

On this continent the Cloudberry extends southward along the mountain ranges to Maine, on the east coast, and on the west coast to South British Columbia.

The plant bears berries of the characteristic Rubus type that are more commonly flattened

Squaw Berry

The Squaw Berry or partridge berry, known to the botanist as Mitchella repens, is a hardy perennial. Its berries are edible, but quite lacking in flavor. It may be expected, however, that they can be much improved through selective breeding.

raspberry-shape or nearly globular, of a bright red or yellowish color, and of a pleasing acid flavor. They are highly prized in all northern countries, being among the best fruiting Rubuses of Norway, Sweden, and Alaska and Labrador in America.

It was my good fortune while in Alberta, along the North Fork of the Saskatchewan River, to see this interesting northern species growing wild. The plants with their small, slender, trailing branches and rounded or almost heart-shaped leaves, were very attractive. Some of the seeds were procured for cultivation.

The seeds germinated perfectly and vigorous plants developed. But, although they were placed in as damp and cold a spot as could be found on my grounds, they did not thrive in the warm, dry atmosphere of a sunny California summer. The change from the northern habitat was too great, and, although the plants lived for a year or two, no important developmental experiments were made with them.

They so obviously found the conditions uncongenial that it was thought best, after a year or two, to discontinue the attempt to reconcile them to the change.

Whoever considers the production of hardy varieties of raspberries, however, should bear the

Cloudberry in mind. It offers obvious possibilities as a hybridizing agent to give hardiness of the most "ironclad" kind to a variety that may lack that essential quality.

Possibly the Japanese Mayberry will ultimately be made adaptable to northern climates by such an infusion of new blood.

The Evergreen Blackberry

As further illustrating the wide range of the bramble tribe, we may refer to a species that is indigenous to the South Sea Islands, whence it was introduced into this country and Europe so long ago that there is no clear record of its coming. Indeed, the precise place of its origin is somewhat in doubt.

The species referred to is the Evergreen Blackberry, *Rubus lacinietus*. In our northwestern states, especially in western Oregon, this blackberry is cultivated extensively. It is popular as a home berry, since it produces fruit from midsummer until late autumn.

As its name implies, this is an evergreen, or nearly evergreen plant. It is a trailing bush with thick perennial canes armed with very stout recurved thorns.

This blackberry was worked upon quite extensively on my place in 1890, and the following years, at the time when my chief experiments in

the hybridizing of the Rubuses were at their height. Among the hybrids produced were some very curious forms, the variation in the shape of the leaves being especially remarkable. Some of the leaves resembled those of the grape, others were much dissected, like the leaves of a wild carrot.

The most promising of the hybrids were produced from a cross between the Evergreen and the popular Lawton blackberry. Some selected seedlings from this cross, in the second generation, were rampant growers, thorny, with curious, handsome, palmate leaves and delicate pink blossoms. The berries ripened late in the fall. Some were rather large and possessed a superior aromatic sweet quality not found in the common summer varieties.

One of these promising hybrids was mentioned in my *New Creations* in 1893. It was never introduced into cultivation, however, as its merits were not quite equal to those of some other varieties of different parentage. But there is no doubt in my mind that if the experiments with the Evergreen blackberry, of this or some other hybrid combination, were carried to a more advanced stage, really useful varieties would be obtained.

The Common Currant

Notwithstanding the importance of the Rubus

Buffalo Berry

This plant is indigenous to the Rocky Mountain region and the dry plains of the West. The fruit is edible and makes a fair quality of jelly. The thorns on the shrub, however, are offensive, and have had a share, no doubt, in preventing its wider popularity. It is adapted to arid regions, and deserves further attention from the fruit developer.

family, its members have by no means a monopoly among the popular small fruits of the garden.

There is at least one other bush that may claim to compete with the brambles in wide range of habitat and in general popularity among gardeners. This, of course, is the familiar currant.

The forebears of the currant grow wild, represented by various species in both Europe and America. The wild red species, *Ribes rubrum,* from which all our common cultivated red, white, and pink currants, large and small, sweet and sour, are descended, is indigenous to both continents. It has maintained its specific identity remarkably through long generations, as the close similarity of the specimens found wild in Europe and America testifies. The more common American wild species, however, in most regions is the black currant, which also has a European congener.

The American black currant is a hardy plant, growing far north in Canada. It varies greatly in different regions, both in appearance and in the quality of the fruit it bears.

There are other wild species and varieties without number, so that there is abundant material supplied the plant developer for work with this valuable fruit.

I have experimented with a large number of

varieties from different regions, and have produced some interesting anomalies. One of these was the result of hybridizing a native red species known as *Ribes sanguineum*. By selection and cultivation, varieties of this plant have been produced on my ground that bore flowers of brilliant colors and the largest fruit, perhaps, ever seen on a currant bush.

Most of the crosses of this species were made between a form collected on Vancouver Island, British Columbia, and the forms native to the regions about San Francisco. The Vancouver forms had long racemes of light crimson flowers and small bluish fruits. The coast form has larger fruits with a more resinous odor, the berries varying in color from bluish to black. My efforts with these species were mostly directed toward increasing the size of the fruit. As just stated, the results are quite noteworthy.

But the experiments are still under way and the ultimate possibilities of development are yet to be revealed.

My experiments in hybridizing the currant have extended to all the species and varieties that I could obtain. At times I have had five thousand currant seedlings under observation.

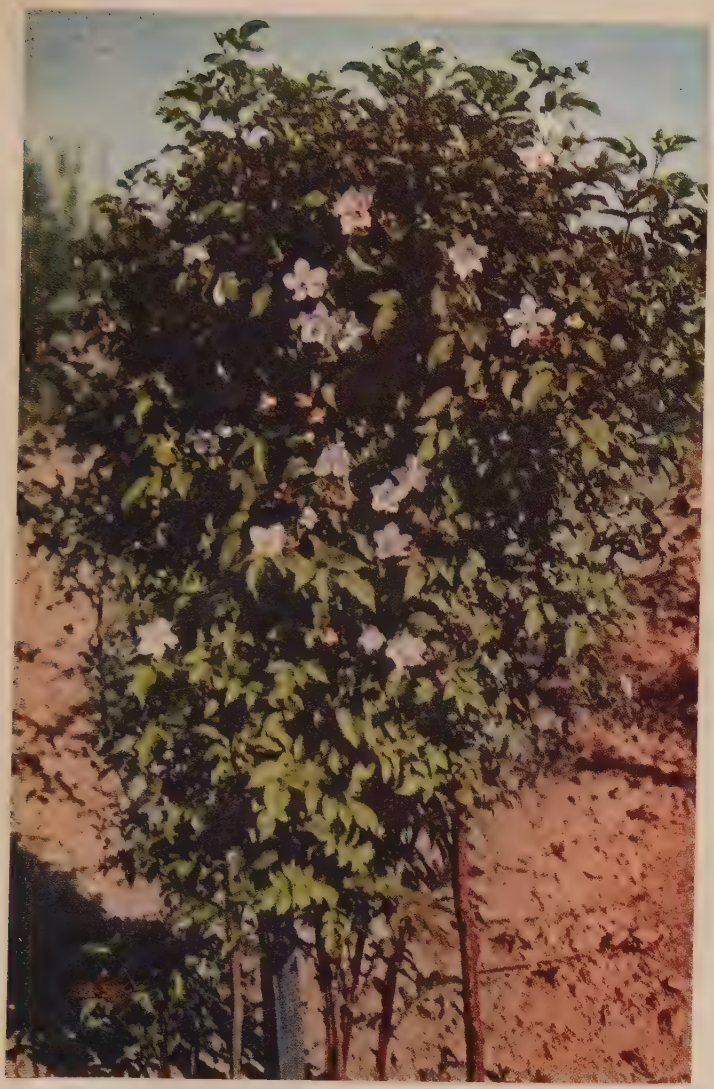
In addition to the European and American species, I have worked extensively on varieties

imported from Japan and China, and from northern Asia and Russia.

I have also crossed the currant with the gooseberry, but the hybrids in this case produced no fruit. Notwithstanding the large number of experiments and their interesting results, I have not produced any new currant that was thought worthy of introduction. There is now under observation, however, a hybrid seedling from the Californian species already referred to—*Ribes sanguineum*, which is several generations removed from the original, and which bears long clusters of very large blue berries with few seeds.

This is the best of thousands of hybrids that I have grown, though I have produced a few really good currants of unique form and flavor, as well as a flowering currant of unusual size and beauty.

All in all, my work with the currants, while substantiating and emphasizing the principles of plant development that work with other plants had made familiar, and while showing many features of interest, has not resulted in any very striking developments; largely, perhaps, because attention was diverted from this line of work to other experiments of greater immediate promise; and because the experiments were too radical, taking in so many species that so many unique characters appeared that I had not time to segre-



The Balloon Berry

An unfamiliar, but promising fruit with which Mr. Burbank has experimented extensively in recent years is the variety of Rubus, called the Balloon Berry, so named because of the shape of its fruit. It may be trained as an upright shrub, and its large white blossoms appear very early in the spring.

gate them. If I had worked with a single species, more immediate commercial results might have been attained. Much of the work with currants was done for its aesthetic and scientific interest rather than for immediate commercial prospects.

The Gooseberry

The currant has a very close relative which vies with it in popularity, particularly in England —the familiar gooseberry. This plant, indeed, is in reality a currant that has developed or retained the habit of bearing prickles both on the stem and on the fruit itself.

This is the practical distinction between the gooseberry and other varieties of currants. All the plants of this tribe belong to the same genus. There are some species in California that puzzle a botanist as to whether they should be classified as currants or gooseberries.

In Europe, and particularly in England, the gooseberry has been cultivated with the greatest possible care and through selection the fruit has been brought to a very large size, superior quality, and unusual productiveness.

But unfortunately the thorns have never been eliminated, except in the case of one or two inferior varieties. These were offered several years ago by an English firm, but their quality of fruit was so inferior that they have not become popular.

Balloon Berry in Bearing

This shows the balloon berry later in the season when in full bloom. It will be seen, however, that there are still blossoms on the vine. The blossoms and fruit are shown in larger view in subsequent pictures.

It has already been mentioned that I was able to hybridize the gooseberry and the currant. The cross is very difficult to make, however, and in my experience the hybrids were sterile. This suggested that the two plants, notwithstanding their affinities as judged from the standpoint of the botanist, have really diverged rather widely. But there are many species of gooseberry as well as of currant, and it would doubtless be possible to find varieties of the two plants that have closer affinity. The hybridizing of these would offer interesting possibilities.

I have experimented extensively with the gooseberry, as with the currant, and have produced a great number of gooseberries of superior quality; none, however, that were really notable.

Some of my most interesting experiments had to do with the native species known as the Coast gooseberry, *Ribes divaricatum*, which grows around Tomales Bay.

I have also worked with the Canyon gooseberry, *Ribes menzieszi*, a tall rapid-growing shrub with rather small leaves and very prickly stems.

The berries of this variety resemble a chestnut burr rather than a gooseberry, the spines occupying the whole surface of the fruit. The fruit itself is excellent in flavor and is prepared for eating by being placed in hot water so as to soften the

Flower and Fruit

The balloon berries have an unusual habit of bearing flowers and fruit at the same time, as here illustrated. It will be seen that the flower is closely related to that of the blackberry. The fruit is also not unlike a blackberry except that it is almost globular in shape.

prickles, after which the pulp is easily crushed out.

I have developed several partially thornless varieties of this gooseberry, and have also had partially thornless ones sent me, showing that the species tends to vary. But the seedlings from these partially thornless plants always produced thorny varieties. It is probable, however, that further experiments might reveal specimens that would drop the thorns altogether and would breed true to thornlessness just as the thornless blackberries do.

This, indeed, should be the aim of the plant developer in connection with all varieties of gooseberries. The plant offers a splendid opportunity for hybridizing and careful selection.

If it could be induced to shed its thorns and still bear large fine fruit, the gooseberry would gain enormously in popularity. At present there is a not unnatural prejudice against this fruit because the thorns constitute an almost intolerable nuisance, their sting being peculiarly irritating.

My own experiments were carried far enough to suggest the probability of the production of thornless varieties. As to fruit, several varieties were produced that I thought superior to any previously seen. But I was not able to introduce them properly, and after keeping them several

The Stalk of the Balloon Berry

The stalk of the balloon berry is very characteristic in form, being almost square. Like most other Rubuses, the balloon berry bears thorns, but the thorns are very small; probably they may be removed altogether by selective breeding.

years the bushes were destroyed to make room for other plants of greater promise. Subsequently, however, I regretted this and now feel that these plants might have rewarded further experimental efforts had I been able to find time for them.

Certainly the gooseberry is well worthy of greater attention, from some plant developer who works along modern lines, than it has hitherto received.

The Hucklebeery and Cranberry

Another interesting tribe of plants supplies us with the familiar market fruits known as bilberries, huckleberries, blueberries, and cranberries.

These berries are little grown in the garden, but remain even to this day products of the wild, although the bushes on which they grow may be taken under man's protection and given a certain encouragement in woodland or swamp.

The botanist classifies the various huckleberries and cranberries in the genus *Vaccinium*. There are widely scattered representatives of the tribe in both hemispheres. Most of them are branching shrubs or creeping vines. A large portion of them are vigorous shrubs like the blueberry and huckleberry; whereas on the other hand the cranberry is a trailing evergreen. The varieties in the different species are so numerous as to tax the skill and patience of the botanist.

The berries are produced in enormous quantities. A mass of blueberries in fruiting time may seem to spread a blue carpet throughout cleared woodlands and pastures. And as to the cranberry, I recall that in my father's meadow where these plants grew, I used to see the men rake the berries off the vines instead of picking them by hand, so profusely were they clustered.

A very interesting feature of the blueberry and cranberry pastures, which I observed even as a boy, was the great variation, sometimes within the same square rod of ground, not only in the size of the berries but in their shape and quality.

From the same patch, some berries would be sweet and highly flavored, others insipid and almost flavorless. But individual patches as a rule appeared to be developed from one original seedling which had suckered out in various directions just at the surface of the ground, the trailing branches rooting wherever they touched the earth.

Individual groups of plants, sprung thus from one seedling, would usually show the same qualities of fruit.

On my last visit to New England I selected from the old blueberry grounds some of the most productive plants, and transplanted them to the experiment farms at Sebastopol.

It has often been stated that the blueberry

cannot be cultivated to advantage, because it ceases to produce much fruit when removed from the wild state. My experiments did not justify this belief, as the bushes brought from the east were if anything over-productive. I have never seen plants of any kind produce a greater quantity of fruit in proportion to the weight of the plant.

During the ripening season the bushes seemed to be a solid mass of berries. This over-production of fruit greatly restricted the growth of the plants themselves.

By way of comparison I one season removed all the fruit from a certain number of the bushes. Relieved of the burden of fruit production, these plants made a large growth, quite outstripping the others; and the second year they produced a splendid crop. I was convinced that under proper conditions the blueberry might become profitable under cultivation in California but had not time to follow up the matter, and all were presently destroyed.

The same fate awaited a collection of huckleberries, bilberries, and other blueberries of various kinds that I had gathered from British America, Oregon, Washington, and even from Norway. More recently I have received an allied plant said to be of unusual value from the mountains of

Interesting Hybrid Berries

Some of Mr. Burbank's most recent and interesting experiments have to do with new types of berries. The boxes here shown contain some second-generation seedlings of crosses between the Balloon Berry and the Hawaiian raspberry. There are also a number of straight seedlings, of both parents, indicating the range of a season's work, along a single line.

Central Japan. No important results from the development of this plant have as yet materialized, however.

The blueberry and huckleberry are extremely difficult to raise from seed. But if kept sufficiently moist this may be accomplished.

Cranberry seedlings can be grown by washing out the seeds and sowing in a protected place or in damp sphagnum moss.

The young seedlings can be transplanted like other fruiting plants, but the operation is rather delicate as with all other Vacciniums. The soil must always be virgin soil, and with hardly a trace of lime, as all Vacciniums prefer what is commonly called an acid soil.

The cranberry, like most other members of the tribe, spreads by sending out runners. It can be propagated by cutting the vines into small pieces. The plant does not thrive in California except in some bogs of the northwestern part of the state. In regions to which it is adapted, however, the cranberry is a crop of considerable importance, and there appears to be a splendid opportunity for someone to conduct experiments for the development of better varieties.

Mere selection from the existing varieties would probably accomplish much. And of course still further progress could be expected if the dif-

A Near View of the Hybrid

These are second-generation hybrids of the Hawaiian raspberry and the Balloon Berry. They were raised in the season of 1914, and have not yet come to bearing. Interesting results are expected.

ferent varieties were hybridized. By such work the crop could without doubt sooner or later be doubled in quantity, the size of the berries increased, and their quality greatly improved.

The most desirable characters for the plant developer to have in mind would be, first, quality of the fruit, next size and color. The vines themselves could be improved, both as to manner of growth and abundant production.

Here as with other berries it would perhaps be possible to eliminate the seed, and this would obviously be of great advantage.

The cranberries differ less than plants that have been more under cultivation, but they nevertheless show enough of variation to give full opportunity for selective breeding; and of course the variation could be increased by hybridizing, as with other species.

Two Interesting Tree Fruits

To conclude this survey of common fruits that beckon the plant developer yet which have been largely neglected, I must make brief reference to the berries of two plants that differ radically from the vines we have had under consideration inasmuch as they are trees or large shrubs rather than bushes.

The plants referred to are the Mulberry and the Elderberry.

Pure Bred and Hybrid Compared

The front box shows second-generation hybrids of the Balloon Berry and Hawaiian raspberry, like those shown in the preceding picture. The box in the rear shows the Hawaiian raspberry unmodified. A comparison of the two types of leaves gives a good idea of the modification effected by hybridization. There is, of course, a considerable range of variation among the second-generation hybrids, giving opportunity for selection.

The mulberry is a relative of the fig, and it bears abundantly a fruit that is distinctly suggestive of the blackberry in general appearance, but which has a characteristic flavor of its own.

Although the fruit of the mulberry is not altogether neglected, yet in general the tree is raised to furnish food for the silk worm or for ornament rather than for its fruit. It is obviously difficult to gather a crop of berries distributed among the branches of tree, and this fact no doubt accounts in part at least for the failure of the mulberry to gain popularity as a fruit producer.

It would be possible, however, to train the mulberry tree to a lower and more spreading growth, as it is generally propagated by grafting after the manner of orchard fruits. Indeed, that is the best way to propagate the fruiting varieties of mulberry, as it cannot be depended on to breed true from the seed. In point of fact the fruit of several of the best cultivated varieties is altogether seedless.

Reference has been made in another connection to my experiments in hybridizing the mulberry with its relative the fig. Notwithstanding the lack of success of these experiments, it seems possible that further experiments along the same line might lead to interesting, and perhaps to valuable, results.

As to the other berry-producing tree just mentioned, the elder, the possibilities of fruit development are even more inviting.

The common European elder, *Sambucus nigra,* has developed into a number of handsome ornamental varieties, most of which are offered by the American nurserymen. Our native eastern species, the *Sambucus Canadensis,* the commen elder of the eastern United States, has also developed several forms; and there is a California species, *S. glauca,* that shows a like tendency to variation, both as to size of tree and size and quality of fruit.

The berries of the elder are borne in large clusters, sometimes in enormous profusion, so that the bushes fairly break under their weight. The fruit is generally bluish black, with a very thick white bloom.

A curious anomaly is sometimes shown by another European or Asiatic species, *S. racemosa,* a variety of which grows in various parts of northern California and northward along the Pacific coast. This sometimes makes a large, rambling, tree-like bush, and the singularity in question consists in the fact that some of the bushes bear berries of a brilliant yellow color and others reddish purple or almost black berries.

The bushes intermingle almost indiscriminately, yet there is no intermingling of the differ-

ent berries on the same bush. Each plant bears exclusively berries of one color or the other.

I have experimented extensively in the improvement of the berries of the different elders and these experiments are still under way.

My experiments began with the planting of seeds of the Mexican elder, which bore berries of medium or small size and of black color. Some of the plants that grew from these seeds produced, much to my surprise, berries yellowish-white in color.

Observing this tendency to variation, I at once surmised that improvements might be made in almost any direction with a plant that showed this tendency. So more seedlings were raised, and selection was made according to my usual method.

From the best of these seedlings many plants were produced that bore berries of a yellowish white or sometimes grayish color. While the berries were bitter, like elderberries in general, I noted that some were less bitter than others. Moreover, there was a diversity in size, and a great variation as to productivity. A few of the trees bore a constant crop all summer, blooming and bearing fruit throughout the season and well into winter.

This was another unusual break in the tradi-

Delicious but Perishable

The Balloon Berry is one of the most delicions of fruits, but it must be eaten almost as soon as picked, as it quickly withers. It is probable that some of the hybrid berries now being developed will retain the good qualities of the parent Balloon Berry and combine these with the keeping qualities inherited from another parent.

tions of the family and one that seemed to offer pleasing possibilities.

The experiment has continued along the lines of further crossing and selection. A few seasons ago I had from twenty-five to thirty thousand elder plants in bearing. From these the best, to the number of about seventy-five, were selected. And the trees of the generation now under observation bear really delicious berries, without a trace of bitterness. Some are quite sweet, others acid.

The best of them are an astonishing improvement over any elderberries I had ever seen before. They make pies of excellent quality.

The berries are grown in abundant clusters and they are individually of the size of small currants. When dried they turn a light golden color, like the whitest of the white raisins. In flavor they can hardly be distinguished from the best raisins, though so notably different in size.

The progress already attained makes it certain that we shall soon be able to educate this elder to a condition that will make it highly acceptable as a productive fruit, especially for arid regions. The elder grows readily from cuttings and will thrive in dry climates.

I have under way also a series of hybridizing experiments in which the different elders, notably

the progeny of the Mexican elder, and the California species already referred to, *Sambucus clauga,* and the hardy Dakota elders are combined. To produce still further variation and facilitate progress, I have also crossed the new elder with species from Ariozna, one of which is a very large tree for an elder.

From a second generation cross I got probably one individual in forty that bore black berries, but from the third generation not a single one out of several thousands was black. I secured, however, one that bore berries of a gray or mulberry color and two or three having a tendency to a mixed color. All the rest were white or amber.

It will appear, then, that a race of elders has thus been produced that bears fruit of an attractive white or amber color and of such quality as to commend it highly, as a substitute for other berries, in regions where the garden fruits in general do not thrive. Moreover, there is every probability that the experiments now under way will result ultimately in the development of varieties of elder of such improved quality as to make a valuable addition to the orchard even in competition with the most popular fruits.

The elderberry has qualities of its own that will commend it strongly. If for no other reason,

the fact of its development on a tree or large shrub gives it peculiar attractiveness. The vine-like growth of many bearers of small fruit, notably the raspberries and blackberries, necessitates methods of cultivating, with perpetual pruning that many horticulturists find irksome. The elder shrub can take its place in the fruit orchard along with the trees that bear apples, or plums, or peaches, requiring no special treatment or attention, and constituting a permanent acquisition for the fruit grower.

—There are opportunities in the by-paths of plant improvement, opportunities untold, which call out for patient specialized effort, and which will well repay the investment of that effort.

Great Opportunities in The Grape

Generations of Grape Experiments Help Us

THE grape is the patrician among climbing plants as the strawberry is among trailers. The family to which it belongs is one of the smallest, as regards number of species, among plant tribes. But it is an oligarchy having very great distinction. What the membership lacks in numbers it makes up in quality. The grape is known everywhere and has been cultivated by man from the earliest times. Doubtless as much attention has been given to it as to any other tribe of plants. Indeed it may be questioned whether there is another that can compete with it in this regard.

Of course the main reason for the extreme favor shown the grape by man has been all along the capacity of the plant to produce a fruit having a juice of unique quality that ferments readily to form a potable beverage.

It is as a producer of wine rather than as a producer of fruit for the table that the vine has everywhere gained greatest popularity.

Nevertheless the quality of its fruit is altogether noteworthy, and such as to give the plant distinction in the eyes of the horticulturist, even were it considered solely as a producer of table fruit. Moreover, there are certain kinds of grape that contain so high a sugar content that they dry without fermenting, constituting a third important commercial product—the raisin.

All in all, then, it is easy to understand why the grape must be considered as a fruit standing in a class by itself, and having importance second to none.

The manner of growth of the grape and the character of the clusters in which its fruit is borne are no less distinctive. No other fruit under cultivation in the least resembles the grape in either regard. And as to shape and appearance of the individual berries no less than in the matter of fragrance and flavor the grape manifests the same individuality. Different varieties show diversity of form and color and flavor, to be sure, but no grape of any variety is likely to be mistaken for a fruit of any other kind whatsoever.

It is clear that we cannot attempt in the space at command to present anything like a compre-

In the Vineyard

The picture gives a bird's eye view of Mr. Burbank's proving vineyard. Here are grapes of many types, many of them combined in new association of hereditary tendencies, undergoing observation and tests. Few portions of Mr. Burbank's gardens have greater general interest.

hensive story of the growth and development and world-conquest of this extraordinary fruit. Nor would it comport with the present purpose to do so. The main facts as to grape culture are matter of common knowledge. Our concern must be with such features of habit, and constitution, and adaptability of the grape as particularly concern the plant developer, and have to do with the possibilities of improvement.

In particular, of course, here as elsewhere, we shall be concerned with a presentation of the work done at Santa Rosa and Sebastopol in connection with the development of this plant.

This, as will appear presently, has looked chiefly to the improvement of the grape as a table fruit. I have not been concerned with varieties of the grape that are especially utilized by the maker of wine. These have been specialized to the point of approximate perfection in the great wine-growing districts, and it would be useless to experiment with them in any region except the one in which they are to be cultivated, because it is well-known that the grape takes directly from the particular soil in which it grows something of the unique qualities of flavor that determine the rank of any so-called good wine in the estimate of the connoisseur.

It is only in two or three small districts of

Grapes of the Concord Type

The familiar, and always popular Concord grape, has, naturally, been given attention by Mr. Burbank. He has produced improved varieties of this grape by direct selection, without crossing, although he has also used the grape in his hybridizing experiments.

France, for example, that grapes are grown from which the clarets can be made that are adjudged superlative in quality.

It does not at all suffice to transplant cuttings of these vines to other regions. It would be necessary to transplant soil and climate also if the grapes are to retain their unique qualities of wine production.

But the case of the grape considered as a table fruit is obviously different. Even though this also is doubtless influenced by the soil, the tests applied to it are not of quite so refined a character, and the grape developed in one region may be expected to retain at least approximately its unique flavor when grown in another climate.

So I have striven to develop varieties that would have commendable qualities of fruit and such qualities of hardiness of vine and prolific bearing as would make them suited to cultivation throughout wide territories.

Here as elsewhere I have had in mind the needs of horticulturists not in one region merely, but in many regions, and have endeavored to produce plants having the widest possible adaptability to varying soils and climates.

The measure of success that has attended this effort in the case of the grape will be partially revealed in the ensuing pages.

Seedling Syrians

Several years ago Mr. Burbank secured cuttings of the best Syrian grapes, brought from Palestine. The Syrian grapes are characterized by a rather slender but strong and wiry stem, and by bunches of pleasing form, all of about one size, and not so crowded on the branch as many varieties of common grapes.

During a period covering 40 years I have probably raised no less than 75,000 to 100,000 seedling grapes from the best table varieties. I have hybridized many varieties, both European, American, cultivated and wild; also other wild species from Mexico, Australia, China, and Japan.

I have likewise attained interesting results by working with bud sports, and with the tuberous grape of Mexico.

Materials and Method

To raise grape seedlings, it is only necessary to gather the seed from the variety desired, and keep them barely moist until planting time. Plant as soon as the frost is out of the ground in well-drained land, in rows about 3 or 4 feet apart. Scatter the seed thinly in narrow drills. Cover with sandy or leaf-mould soil, about one inch deep in a humid climate, a little deeper in dry soil like that of California.

In the latter case it is well to have the upper half of the covering of sawdust, so that the seedlings do not have too great a weight to lift in pushing through the soil.

During the summer the very poor seedlings, those which are attacked by mildew and which have made weak, uncertain growth may be uprooted at once, giving the others a better chance. Later, while the plants are dormant, transplant

An Improved Eastern Grape

This picture shows an unnamed type of grape bred from Eastern parents, and greatly enlarged and improved by Mr. Burbank. There are few grapes to the bunch, but the individual fruits are large and of luscious quality.

the most promising of these to rows about 12 feet apart, the individual plants being from one to two feet apart in the rows, according to the variety.

Like most other cultivated fruits, grapes do not come true from the seed. Among American grapes, if seeds from a vine bearing black fruit are planted, about 99 out of 100 black-fruited seedlings may be expected. With red grapes about the same proportion will follow the parent color. But from a white grape probably less than one-fourth will come white.

With the European grape, *Vitis vinifera*, the most variable and commercially the most important species in the world, the proportion would be wholly different in most cases. Planting a red grape one may expect half red or half black, the tendency being slightly more toward red or black grapes than white, but the proportions varying indefinitely.

Certain qualities of the inherent constitution of the plant are markedly heritable.

Thus the seeds from a strong-growing grape vine are likely to produce strong-growing seedlings. Productive grapes will usually produce a high proportion of productive seedlings. A grape subject to mildew is almost certain to produce a large proportion of seedlings subject to mildew.

A variety having abnormally large leaves will

A Mammoth Cluster

This seedling grape, still unnamed, is a complex hybrid, developed in Mr. Burbank's vineyard. The individual fruits are not large, but they are notable for the extraordinary number in a bunch, as the picture will show. They are also of excellent flavor.

not often reproduce that tendency in its seedlings for an abnormality is more apt not to reproduce itself, there being a tendency to return to the normal condition, which has existed for perhaps a thousand years.

By planting seeds of an early grape, a great proportion of early grapes would be expected, and vice versa, but in almost every case both early and late, large and small, black and white, sweet and sour, strong-growing and weak-growing grapes will be produced among a lot of grape seedlings from any variety which has been long cultivated and is the result of hybridization.

In a wild species, the variation would be mostly in the size of the plants and very little in any other respect.

The first crop of fruit on the young vine is not a very accurate test of its future fruiting capacity. Almost without exception the fruit improves each season for several years both in the size of the bunches and in the quality of the fruit.

Grapes from Many Lands

With the grape as with other plants I have sought material for development in far places; but have also utilized the native species. A brief notice of the different species that have contributed to the experiments will suggest the scope of the work.

Good Size and Fair Quality

This seedling grape, also of very complex heredity, is one of a great number of new varieties that Mr. Burbank has under observation. Its chief fault is that the bunches lack symmetry.

An interesting local species is *Vitis Californica*. This is an extremely strong vine, climbing a tree to a height of 75 or 100 feet. It is often found along the banks of creeks and rivers where it may attach itself to a young alder. As alder and grape grow, the tree supports the vine until it reaches a height of sometimes 100 feet and has a trunk 12 to 18 inches in diameter—which may seem almost incredible to eastern people unfamiliar with our flora.

The fruit of the California grape is produced in small quantity and is quite variable in this locality. It ripens late, is sour, without flavor, and is generally insignificant in all respects. It is sometimes used for jellies and even for wine.

Of the world-wide and supremely important commercial species commonly called the European grape (*Vinus vinifera*) I have worked largely with the Tokay variety with the idea of inducing this vigorous vine, which bears such an abundance of large, handsome fruit, to combine hardy qualities and freedom from mildew with its characteristic excellence of fruit.

The fruit of many of the seedlings is quite acid, but some are far sweeter than the Flame Tokay, and much earlier, which is most important as the Flame Tokay ripens too late for our coast climate.

These seedlings have of course been rigidly

selected to avoid mildew, susceptibility to which is one of the faults of the Tokay, especially in the coast region. Some of the seedlings of the Flame Tokay are white, some black, some reddish, some of a blue-gray color. Very few of them resemble the Flame Tokay in form, color or quality of fruit, most of them incline to the round form of the ordinary *V. vinifera.*

It is not uncommon to find natural hybrids of the California grape and the European grape growing wild alongside the vineyards. The strains of the California species are in some of the strongest-growing forms of cultivated grapes that are recommended as stocks for the varieties of European grape that are subject to injury from phylloxera.

Work With Strange Species

Mr. M. K. Seralian, who removed from Palestine to America some years ago, secured cuttings of the best Syrian grapes. The vines from these cuttings have habits of growth not unlike those of the Flame Tokay seedlings planted at the same time, and are now about the same size.

Among them is one identical with our so-called Sweetwater grape.

Another was certainly Thompson's Seedless—a stray variety renamed since it was imported to California about 1880, and recently identified as

Sultanina. It is an extremely productive, light colored, strong growing, yellowish-white grape which has to be pruned longer than most others of the *vinifera* class in order to get big crops which it produces under ordinary vineyard cultivation in California.

Sultanina and another called Sultana are grapes of medium size but absolutely seedless. They are put up in great quantities in California as seedless raisins, and are displacing the dried grapes of Corinth or so-called Zanta currants so extensively imported from Greece and Turkey—to which they are greatly superior.

Among these seedling Syrian grapes there is one early and productive class, absolutely new to California growers. Most of the Syrian grapes are noticeably different in several particulars from the other grapes of Europe and northern Africa.

The stems are more slender, the peduncles quite small, yet strong and wiry, the bunches are very pleasing in form, the grapes usually being set full and all of one size, and the bunches are not usually so crowded as those of many varieties of the common grape. The seeds also are very small—almost absent. Yet all of the varieties among this lot of twelve or more produce some seeds, with the exception of the Thompson's

A Nearly Seedless Grape

This seedling grape, which reveals the characteristics of ancestors of Asia and Europe, is nearly seedless. It is not large, but it has qualities of flavor that are scarcely excelled by those of any other variety of grape.

Seedless. The seeds, however, are quite tender, being hardly noticeable. The skins of most of them are thin and transparent.

Having raised a great number of seedlings from these Syrian grapes, I find them to be remarkably precocious, coming into fruitage early, remarkably heavy croppers, and while more uniform in character than most of the *vinifera* seedlings, yet they nearly all contain an astringent principle which is seldom found in the ordinary grapes. With this exception, they are the most promising lot of seedlings which I have hitherto raised.

About 1890 the U. S. Government imported a lot of grapes from the Mediterranean region, but none of them compared with these Syrian grapes, which seem to be distinct, and some of which will probably prove of great value to California.

Most of these grapes are oval in form, not round as is usual with other grapes.

The *Vitis antarctica*, which has several other botanical names, is a curious climber from Australia which I have grown many times from imported seed. It is a little tender and especially sensitive to wet weather, and though it is interesting I have not experimented much with it.

The *Vitis Coignetiae* from China is an exceedingly strong-growing vine with immense leaves.

Unproductive but Meritorious

Like all of the seedlings now in Mr. Burbank's vineyard, these two are of mixed ancestry. Both have qualities of size and flavor that commend them highly, but they are somewhat lacking in bearing qualities.

The foliage is beautifully colored in the fall—scarlet, crimson, yellow, or brown. But there is a great diversity in the seedling vines in the color of the foliage. Those with brilliant scarlet autumn colors are generally considered the best. There are also crimson ones. There was a vine growing on my Sebastopol bungalow for years which bore small clusters of insignificant fruit, but handsome foliage.

The *Vitis hypoglossa* is another uncommon grape which I have grown for my own amusement and interest.

The *Vitis rotundifolia,* which has also half a dozen more botanical names, is a tremendous grower. It must be thinned out quite extensively in order to get any fruit; the seedlings of these make a mass of foliage and small branches, so there is no opportunity for the vines to produce much fruit.

The various Scuppernongs are derived from this southern species. I have grown them from seed on numerous occasions. In a few cases these have produced scanty fruits, but they were finally destroyed as they make too much growth and too little fruit.

I have also grown the mustang or overbearing grape, *V. Candicans;* the sugar grape, *V. rupestris;* the *V. monticola, Texana* or *Foexeana,* the *V.*

Faults of Another Type

This seedling grape produces good-sized bunches with an adequate number of individual fruits; but a glance shows that there are far too many small grapes in the bunch. This defect must be remedied by further crossings before the grape is worthy of introduction, notwithstanding the fine quality of the fruit.

vulpina or *cordifolia*—in fact I have worked more or less with nearly or quite all the North American species and many of the hybrids produced by Mr. Munson and others.

Seeds of the tuberous grape of Mexico have been sent me several times. It seems to require a thoroughly well-drained soil and a very warm climate.

The first two lots of seeds received were failures on account of being placed in irrigated soil which was not suitable to them.

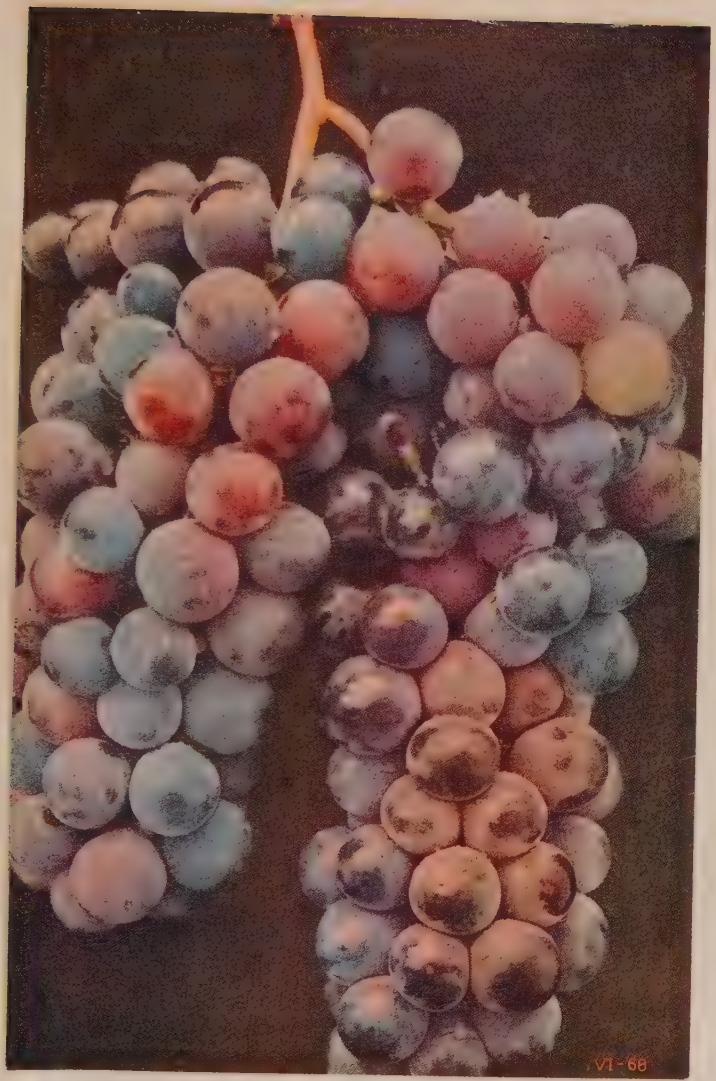
Some of the third lot of seeds were placed in sandy, well-drained soil, and made large vigorous vines the first season. They somewhat resemble the Muscat of Alexandria in foliage and growth and have rather large, sweet, potato-like roots. However, our winter climate did not suit them and these also died, so I have made no further attempt at raising them.

These Mexican tuberous grapes are said to produce a fine fruit in large clusters, much resembling the Muscat of Alexandria.

Variations in Seedlings of a Bud-Sport

My constant effort to take advantage of any disturbance in the heredity of a species or variety is justified strikingly in working with the grape.

The best seedlings which I have ever produced were from the grape called Pierce or Isabella



"My Early Black Grape"

This grape shows the Concord influence, but has strains of various other species. The merits of this new variety are numerous and conspicuous, and its defects are few. It is undergoing further observation, however, before being introduced.

Regia, a variety which originated as a sporting branch from the common Isabella on Mr. J. P. Pierce's place near San Jose, Cal.

This Pierce grape is the same color as its parent, the Isabella, but the berries are more than twice as large though not increased in number on the cluster. The vine is very much stronger and the foliage much larger, so much so that the difference is noticeable at a considerable distance.

Large quantities of seedlings from the Isabella Regia were raised, partly for the purpose of noticing whether bud-sports would reproduce themselves from seed and partly because it promised to be a fine variety to work upon for improvement.

Among the numerous seedlings which were fruited the variations were most astonishing, much more so than with most grapes.

Whether this is on account of the Isabella having been moved to a new climate, thus changing its hereditary tendencies, or whether bud sports in general are apt to produce more variable seedlings, I am not yet able fully to demonstrate. Some of these selected vines which were fruited are unusually strong growers, some were as weak in growth as the ordinary cultivated varieties of grapes; some bore enormous bunches of grapes, some had only a few small clusters.

The Chinese Wart Grape

This visitor from the Orient, which assumes, as will be seen, an interesting development of foliage coloration in the fall, is undergoing special observation and development in Mr. Burbank's garden at Sebastopol. To what extent improvement is practicable will be determined by the work of future seasons. Conceivably this grape may have some such influence in our vineyards as the Oriental plum has had in our orchards.

One of these Isabella Regia seedlings is the earliest grape ever recorded, ripening nearly a month before the Early Amber, Sweetwater, and other American and European grapes. It is, however, small in size and not productive.

THE EARLIEST AND LATEST GRAPES ON RECORD

Another very large black grape, produced on a large, vigorous vine, ripens nearly five weeks before its parent. This is the earliest large grape known. It has very delicious flavor and quality. It was temporarily called the "Early Black," but was subsequently rechristened the Montecito by Mr. John M. Rutland, who purchased it for introduction in Australia.

In contrast with these early-ripening seedlings are others that do not fully ripen their fruit until December and January. These are valuable in California if protected from the rains, as they extend the season almost indefinitely.

Though the parent plant bore black grapes, some of the seedlings bore white, yellow, red, or purplish-black fruit. Some varieties were enormous producers.

Owing to pressure of other matters, I have made no attempt to introduce any of these grapes, but am satisfied that none can compete with some of them for table use.

Among the seedlings of the second generation

Grapes of the Labrusca Type

The Vitis Labrusca, indigenous to the eastern United States, is the native species from which the Concord and Catawba types of grapes, including the Niagara, Brighton, and numerous other varieties, have been developed. The variety here shown is of mixed heritage, but reveals the preponderant influence of the Labrusca.

raised from my own vines were three anomalous vines, of great interest. One of these was the exact counterpart of the California wild grape.

The second was closely similar though not quite identical; and the third might be called a hybrid in general appearance.

As there were no wild California vines growing within fourteen miles of the place where these grapes were growing, I can only account for the appearance of these degenerates, as they might be called, on the theory that our wild California grape and the eastern wild grape from which the Isabella originated were descended from a common stock, and these three plants were reversions.

Two of these vines grew the first season to the height of nearly eight feet when the other seedlings had grown to only one or two feet in height. The third one grew twelve feet or more, while most of the others had grown only about as many inches. The foliage was exactly like the California wild grape, as was the wood, fruit, and general appearance throughout.

These seedlings have created much speculation as to their origin among experts who have seen them. They are best explained, I think, on the theory proposed above.

Nearly three-fourths of the Isabella Regia seedlings bore partially seedless fruit. About

A Fine Specimen

An unusually large seedling grape with a fine flavor. It would almost seem as if in this seedling the weight of grapes which would ordinarily be found on a large bunch had been combined into a few fruits individually of exceptional size. Bunches of this size are very convenient for serving on the table.

A Heavy-Bearing Seedling

This complex hybrid bears large bunches of grapes of uniform size and in enormous profusion. It has nearly all of the qualities of an ideal grape, but there are scores of other varieties in Mr. Burbank's vineyard which successfully compete with it.

half the grapes on each bunch usually were altogether seedless. Some entire clusters were seedless. Yet other vines of the same fraternity bore fruit in which the seeds were unusually large.

By selection among these vines I have developed several races of nearly seedless grapes that are of exceptional quality. The best of these will be introduced, and they will also be of value in hybridizing experiments for the production of seedless grapes of other varieties.

Once produced, such varieties must obviously be propagated by cuttings, but this of course presents no difficulties.

The matter of hybridization, crossing, and selection of fruit having been gone into quite extensively in early chapters, only a glimpse of the special features of the work with the grape has been here recorded. The methods of crossing and selection having been discussed in previous chapters, it would be mere repetition to give them here; and for this reason the details have not been elaborated as fully as in some chapters on other fruits.

A great number of experiments with the grape are now being carried on that are approaching completion, and I have a large number of unique and valuable grape varieties which are awaiting introduction.

Cactus Fruit on the Slab

This picture suggests the enormous productivity of Mr. Burbank's perfected varieties of cactus. The slabs here shown are in no wise exceptional; indeed they bear no more than an average number of fruit. Sometimes a single slab bears more than fifty of these "pears."

The Cactus Pear—
A Profitable Fruit

Its Flavors Fixed, Now Working Mostly for Seedlessness

THE story of the spineless cactus has been briefly outlined in an earlier volume, and will be told in detail in a later one.

There is no more important story to be told in connection with the record of my entire work, but it would not comport with the purpose of the present chapter to go into details as to the manner of development of this extraordinary plant. For the moment, we are concerned solely with the fruit of the cactus. In the present chapter it will be considered altogether from that standpoint.

It should be explained at the outset, however, that whereas the improved forms of cactus pear about which we are speaking are grown on the spineless cactus plants, yet the fruit itself is not yet altogether without spicules.

To remove the spines from the cactus slabs—as the "leaves" are commonly termed—was a task

requiring somewhat less time than the removal of the smaller spines, and in particular of the very minute spicules, from the fruit.

The reason for this is not that the spines of the fruit are more fixed and intrinsically more difficult of removal than those on the body of the plant itself, but merely that the work must progress more slowly because it is necessary to wait for a term of years, sometimes four or five, before the cactus plant comes to the fruiting age when grown from seed. Unfortunately it cannot be predicted from observation of the plant itself whether or not it will bear spiny fruit, so it is necessary to wait until the plant comes to fruiting age before its characteristics in this regard can be known.

On the other hand, the character of the plant itself with regard to spine-bearing is revealed immediately when the first tiny shoots come up from the seed. So selection may be made at once among the company of seedlings, and by weeding out those that show any propensity to bear spines, and selecting those that are smooth, the experiment may go forward with relative rapidity.

We know that we are making no mistake in our selection as regards the bearing of spines on the flattened stalks of the plant, because their character as to this is fixed from the outset, and

A Mammoth Specimen

Some fruits of this size grow to the number of from twenty to fifty on a slab, and it is easy to see that the aggregate production is enormous. In point of fact, the amount of fruit grown on a single acre of Mr. Burbank's new perfected spineless cactus, under favorable conditions, may amount in the aggregate to more than 100 tons in a season. In point of bulk, the crop of the cactus is without rival.

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is as definitely revealed when the plant is an inch high as it will be when it has attained mature growth.

But, on the contrary, our selection made in the hope of securing plants that would bear spineless fruit of excellent quality may prove eventually to have been hopelessly faulty. After waiting three or four or five years we may discover that the plants on which our hopes had been chiefly based bear fruit as spiny as that borne by their ancestor whose habits we are attempting to enable the plant to shake off.

Nevertheless, the work of removing the spines from the fruit of the cactus has progressed to a stage where the spicules are not only reduced in size, but are so loosely attached that they may be readily brushed from the fruit with a wisp of grass. And the plants under observation include many in which the tendency to drop the spicules from the fruit has advanced progressively, warranting the confident expectation that in the next generation there will be some that will present fruit altogether smooth.

I have every expectation that when the plants of the most recent generation come to bearing this year, there will be some that produce fruit as smooth-skinned as the slabs of the mother plant itself.

A Luscious and Succulent Fruit

Mr. Burbank has developed so many varieties of cactus fruit, that there is something like the same range of variation that is found among cultivated apples or pears. All the best fruits, however, are exceedingly juicy and succulent, and most of them are of very appetizing flavor.

Should this prediction come true, my ideal of a spineless cactus bearing smooth-skinned fruit will at last be realized.

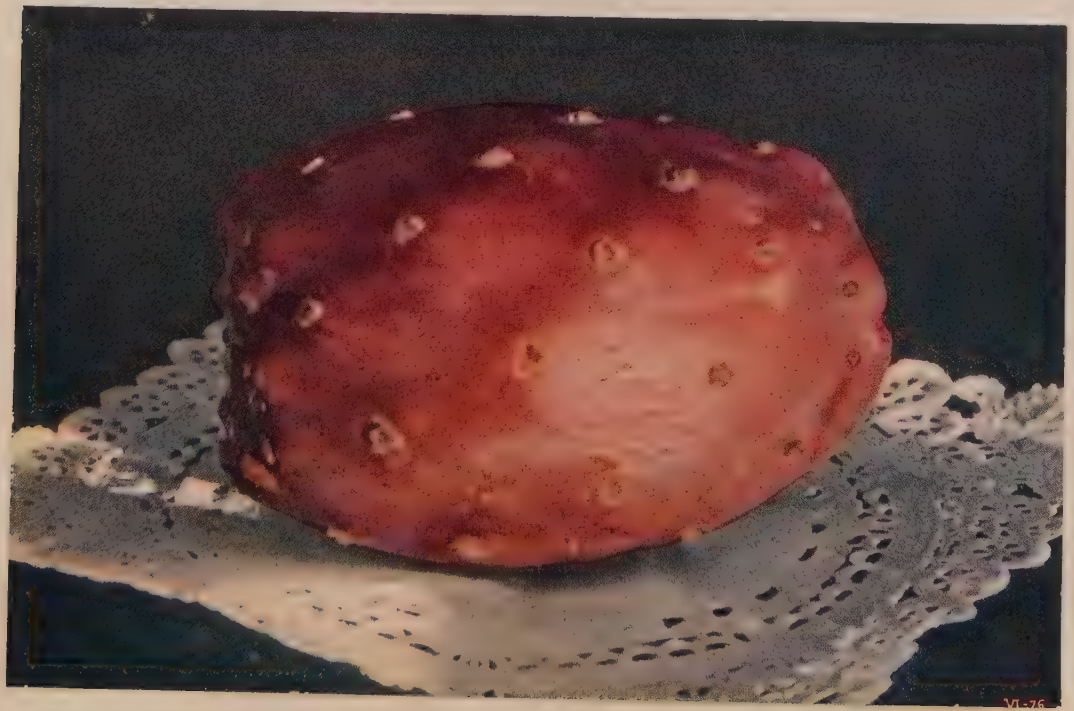
The Character of the Cactus Pear

Meantime the endeavor to improve the size and quality of the cactus fruit has met with signal success.

Generation after generation, the "pears" grown on the improved cactus plant have kept pace with the improvement of the plants themselves, until the different new varieties of cactus now bear fruits almost as varied in quality as the different varieties of apples, and perhaps rather more varied than the different varieties of cultivated pears.

The fruit of the wild species of cactus varies widely in size and form, as well as in texture and flavor. My cultivated varieties, however, have been made to assume an almost uniform oval form. Or perhaps barrel-shaped would better describe the new cactus fruit. The individual fruits are three or four inches in length, and in some cases they weigh half a pound, although the average weight is considerably less than this.

The skin of the fruit is readily removed by cutting off a thin slice at each end and making an incision the length of the fruit, and peeling the skin back.



Easy to Eat

The cactus fruits are not altogether spineless, but in the improved varieties the spines may easily be removed by brushing with a wisp of grass. The skin is of firm texture and peels off very readily, and you may then bite into the firm flesh as you would into an apple.

The pulp thus exposed is as juicy almost as the pulp of a watermelon, but much more compact, as well as sweeter and of better flavor.

Pulp and skin are usually of about the same color; but the range of color is wide with the different varieties, varying from white through the shades of yellow, green, orange, pink, purple, crimson, and the most vivid blood-red to deep purple—almost black.

In flavor there is also wide variation. The flavor is characteristic but difficult of description, as it does not bear close resemblance to the flavor of any familiar fruit. There is a wide range of variation as to degree of sweetness and exact flavor, just as there is between different varieties of apples or pears.

The cactus pear further resembles the orchard fruits in that it may be eaten raw, or may be cooked or variously preserved. It is, in a word, an all-round table fruit, and as such constitutes a very important addition to the dietary. It is best eaten raw.

Astounding Productivity

Not only are the individual fruits large and luscious, but they are produced in the most amazing profusion.

Some of the seedlings begin to bear fruit the second year, but they do not come into full bear-

Shown in Cross Section

This picture suggests the quality of the flesh of the improved cactus fruit. It is of the right texture exactly to bite into —especially on a hot day.

ing—so that the fruit may be accurately appraised —until the third or fourth year. Then the fruit may be produced so abundantly as to check the growth of the plant. When the cactus has come to mature age, it puts forth such an abundance of fruit as sometimes almost to hide the slabs from which the fruit grows. Half a hundred individual fruits may grow on the edges or surface of a single slab.

Looking across a field of cactus in full fruit, one sees a mass of fruit that almost hides the plant.

It has been found that eighteen thousand pounds of fruit per acre is a common crop on the poorest soil. The possibilities of production on good soil and with fully matured plants of the perfected varieties are probably greater than those of any other fruit-producing plant whatever.

It has been estimated that the product of a single acre may amount to the astounding quantity of one hundred tons.

Whoever has seen a field of my giant cactus plants in full fruit will not be disposed to challenge the estimate.

Analysis shows that the fruit contains about fourteen per cent. sugar together with a small amount of protein and fat. The precise apportionment of the constituents varies greatly with

The Symmetrical Type

Many varieties of cactus have fruit that is almost perfectly oval in form. This is an excellent trait in a fruit intended for shipping. The cactus pear has other qualities that make it a good shipping fruit, as repeated tests have shown.

different varieties. It is possible to increase the sugar content and otherwise to vary the chemical composition of the fruit by breeding and selection, just as can be done with the apple, the peach, the plum, the sugar beet, and most other fruits and vegetables.

The cactus fruits developed at Santa Rosa are of exceptional size and superior quality, but of course they do not constitute an absolutely new departure, for it is well-known that there are many varieties of spiny cactus that bear edible fruit.

Indeed, in certain arid regions, and in particular about the Mediterranean, the fruit of the cactus has long been recognized as a valuable food product. Professor Leotsakos of the Greek University at Athens, who visited my grounds one summer recently, tells me that the cactus fruit is a very important part of the dietary of millions of people around the Mediterranean for about three months of the year. He declared that he himself would prefer a half dozen good cactus fruits for breakfast to the best beefsteak.

He considers the fruit both nutritious and healthful, and this estimate is universal in countries where it is largely eaten.

It is the custom in Greece, especially along the seashore, to collect the cactus fruits in the morn-

A Pear-Shaped Cactus Fruit

The fruit of the cactus is commonly spoken of as a "cactus pear." The appropriateness of the term is suggested by this particular variety, the fruit of which is distinctly pear-shaped. This variety retains more of the primitive form of fruit than most other of Mr. Burbank's perfected fruiting Opuntias.

ing and store them in some cool place, either with ice or in a basket of sea water, which is said to improve the flavor of the fruit. Both wealthy and poorer classes eat the fruit at each meal throughout the season, according to my informer. So important is the cactus fruit regarded in Greece that Professor Leotsakos assured me that he would make haste on his return to communicate with the Government officials, that they might at once take steps to obtain my improved varieties for planting; for, of course, no variety of cactus hitherto known approaches the new hybrid species in quality or productivity.

It appears that the cactus fruit is usually known about the Mediterranean as the Indian Fig.

In this country it has been commonly referred to as the Prickly Pear. But now that the prickles are marked for elimination, this name will cease to be appropriate, and we may conveniently refer to the fruit as a Cactus Pear, unless some more distinctive name should be suggested.

Various Uses of the Fruit

The juice of the crimson variety of the cactus fruit is a brilliant carmine color that makes it very valuable for coloring ices, cakes, and confectionery. It is not only absolutely harmless but positively nutritious and beneficial, and is sure to gain popularity; taking the place of the arti-

A Sturdy Variety

All of Mr. Burbank's perfected spineless Opuntias are very complex hybrids. As usual with hybrids, these plants show a marked tendency to wide variation. Even where the slabs are comparatively uniform, there is great diversity in form and color of fruit, giving the plant developer a free hand in selection.

A Nearly Globular Cactus Pear

Here is a cactus fruit that is not at all pear-shaped, having rather the contour of a well rounded plum. In size and shape it is not unlike a large Standard prune; but the clusters of spicules on its surface leave no doubt as to its identity.

A Well-Proportioned Pear-Fruit

This variety is perhaps nearly perfect in size and shape. It is not too large for comfortable handling, and it is of almost the best possible shape for compact storage during shipment. It has also qualities of flesh that highly commend it.

ficial dyes that are now used so extensively, some of which are of doubtful wholesomeness.

In Mexico the crushed fruit of the cactus after peeling and having the seeds strained out is sometimes cooked and dried and made into little loaves weighing from one to two pounds each.

These cakes have a rich, sweet, honey-like flavor, to which the Mexicans are very partial. If carefully made they are very appetizing and wholesome. Indeed they constitute an important article of food, and are considered a luxury, having the qualities of a nutritious confection.

Cactus fruit, indeed, in any form is in high repute in many tropical countries, being in some regions regarded as of value in renal diseases.

Relatively large proportions of salts of magnesia, soda, potash, and lime in the fruit, in readily assimilable form, have been supposed to give it particular value, especially for residents of the tropics. The effect on the digestive organs is also very favorable. Even the leaves of the plant are made into pickles that, in the case of some varieties, are regarded as having a flavor equal to that of the cucumber. Most varieties, however, have a mucilaginous quality that is objectionable. This, of course, refers to the tissues of the plant itself, not to the fruit.

It has been said that the cactus fruit in point

A Cluster of Cactus Pears

This shows the typical and characteristic distribution of the fruit about the borders of the cactus slabs. It is not unusual, however, for a fruit to appear also on the sides of the slab, starting from amidst the clusters of spicules; or, in case of Mr. Burbank's spineless varieties, from the indentations that mark the former location of the spicules.

Another Cactus Fruit that Imitates the Pear

Fruit of this type is not quite so well adapted for packing as the oval type, but many people like a pear-shaped fruit, and this form has been retained in a number of Mr. Burbank's best selected varieties.

Cactus Fruit Approaching Spinelessness

The one prominent defect of the cactus fruit is that it retains a certain number of spines or spicules, even when the slab upon which it grows has become entirely smooth. Mr. Burbank's experiments are now directed towards the production of a perfectly spineless fruit, and those experiments are approaching completion. The variety of fruit here shown is almost smooth, retaining only traces of the offensive spicules. It is believed that other varieties, almost at fruiting age, will bear pears that are altogether spineless.

of juiciness and texture is suggestive of a melon. Some people have compared its flavor to that of the cantaloupe. In other varieties the flavor suggests the raspberry.

But, as already suggested, there is no standard of comparison that gives a clear conception of the taste of the fruit.

The one conspicuous drawback is that the cactus fruit is filled with seeds. In the case of some of the wild varieties, the seeds are large and especially hard, but even these are habitually swallowed by the people who eat the fruit. The improved varieties have seeds scarcely larger than those of the tomato, although a little harder, and they may be swallowed with impunity.

I have never known of anyone being injured by eating the cactus fruit in any quantity.

It goes without saying that I have long had in mind to remove the seeds from the fruit of the perfected varieties of cactus fruit. Something has already been accomplished toward this in the reduction of the size of the seed as just referred to. But it will require a long series of experiments to eliminate the seeds altogether. The seeds are not collected at the center of the fruit as in the apple and pear and allied fruits, but are distributed somewhat evenly through the pulp, after the manner of the seeds of the watermelon.

Cactus Fruit Approaching Seedlessness

Many persons do not object to the seeds in the cactus fruit; others, however, find them distasteful. In order to meet all tastes, Mr. Burbank is now attempting to remove the seeds from some of the varieties of cactus fruit. The specimen here shown is approaching seedlessness, and it is probable that other varieties to be developed in the near future will be altogether seedless. The spineless and seedless cactus, retaining its succulence and flavor, will be a very meritorious fruit.

I have no doubt of ultimate success in eliminating the seeds altogether.

But as we have seen in connection with other plants, the seed is about the last thing that the plant is willing to relinquish, for the excellent reason that it is an all-essential part for the propagation of the species in a state of nature. But the cultivated cactus plants do not need their seeds, and I have every expectation of being able to induce them to relinquish them.

A specific account of the methods through which it is hoped to bring about this development, together with a detailed description of the origin of the spineless cactus itself, will be given in a later volume.

—Eighteen thousand pounds of cactus fruit to the acre has been found to be a common crop on even the poorest soil.

Some Inedible Fruits Which May Be Transformed

Even the Acrid Barberry Is Changing

WE have had occasion more than once to call attention to the extraordinary importance of the Rose family in its relations with man, and in particular to the wonderful value of the great genus *Rubus*.

The family gives us an astonishing proportion of our cultivated fruits and berries, in addition to a great variety of our most beautiful flowers. The apple, peach, plum, cherry, quince, pear, loquat, apricot, among orchard fruits, and the blackberry, raspberry, dewberry, Salmonberry, Cloudberry and strawberry, among small fruits, are all representatives of the same tribe.

Moreover, there are several minor fruits that claim membership in the family to which reference has not hitherto been made, but some of which will be introduced in the present chapter.

Any plant that has membership in the family

must be regarded as having possibilites of development.

It was perhaps largely a matter of chance that the fruits we have mentioned came under man's tutorage at an early date and thus were developed to their present status.

Some other members of the family, such as the hawthorne, the mountain ash, the wineberry, the Juneberry, the thimbleberry, and the bridal rose, have failed to be taken under man's protection and hence have not had their fruiting possibilities developed. But some at least of these are well worthy of consideration, and from among them there will doubtless be developed sooner or later many new varieties of fruit that will be considered valuable acquisitions.

We shall be by no means confined, however, in the present chapter to the consideration of members of the wonderful rose family. We have already seen that there are other families having members that bear admirable fruits, even though no single family shows so long a roll of important members.

We shall now have our attention called to yet another coterie of fruit bearers of which good things may be expected. Some of these are familiar natives or plants that have become acclimated in this country, others are foreigners known

only to the specialist. The fact that at least one or two of them are known as bearers of interesting or beautiful flowers and have been cultivated for ornamental purposes adds interest, and makes the outlook for the development of their neglected fruiting possibilities seem still more enticing.

It should perhaps be added that a few of the fruits to be referred to here are not absolutely inedible even in their present state. But no one of them is to be compared with our standard orchard and garden fruits. At most they show promise of development; and, indeed, it is their lack of present quality combined with their promise of adaptability that makes them peculiarly attractive.

Almost any one of the potential fruit bearers about to be named offers inviting opportunities for the fruit developer. And some of them are so readily accessible and so responsive to efforts made in their behalf as to make particular appeal to the amateur.

Improving the Barberry

Those who have seen the common barberry with its beautiful, holly-like, green leaves and abundance of blossoms in the early spring, and who have also noted the attractive crimson fruit it bears in the fall, will readily understand why I undertook to improve this shrub with particular

reference to making its fruit attractive to the palate as well as to the eye.

This is a member of a rather large company of plants that combine decorative appearance with the capacity to bear valuable fruit. But it is well known that the possibilities of the barberry in the latter regard have never been developed beyond the initial stages.

Beautiful as the fruit is, it is altogether inedible (except when it is utilized for jelly) or was at the time when my experiments with the plant began.

When I say that my work with the barberry was taken up more than twenty-five years ago, and that I have not as yet produced a variety that seemed worthy of introduction as a fruit producer, it will be understood that this plant is not among those that are responsive to the efforts of the plant developer.

It should be explained, however, that the work with the barberries, although it has involved the growing of thousands of seedlings of various species, has been carried out purely along the lines of selection, without the aid of hybridizing. It is almost certain that crossing the different species would have resulted in carrying the work forward more rapidly. But the pressure of other work has kept me from undertaking this, and I have been content to select the best specimens of the various

The Passion Flower

The Passion Flower is best known for its very curious blossom, a good example of which is here shown. For the most part the merits of the plant as a producer of fruit have been neglected. Mr. Burbank, however, has been experimenting widely with different species, and has developed the fruit until it gives good promise, although it is not as yet at a marketable stage.

species, generation after generation, up to the present time, and thus to advance somewhat slowly, although on the whole rather surely, preparatory to getting improved varieties of each species for crossing.

The most promising of the barberries from the standpoint of the fruit grower is probably the common species familiar in many regions as a hedge plant and known botanically as *Berberis vulgaris*. The genus has many other species, however, and the fact that these tend to vary indicates to the plant breeder that they have inherent possibilities of improvement. In the course of this work I have imported other species of barberries from South America, British Columbia, Asia, Europe, and Northern Africa.

Some of these have proved of value, but the most important advance has been made by the progeny of the common barberry.

During the course of the twenty-five years of experience with this plant, I have been able by persistent selection to facilitate the development of a fruit much larger than that of the parent form, far better flavored, and with a greatly reduced proportion of seed. The fruit has not changed very markedly in appearance but is produced much more abundantly.

It has all along been noticed that when seeds

are planted there is a marked tendency on the part of most of the progeny to revert toward the wild state rather than to go forward, according to man's interpretation of progress. So it is only the exceptional plant that can be saved with any prospect of producing valuable fruit. Nevertheless, as already noted, there has been marked progress and it is always to be remembered that such progress tends to be cumulative and that there may come a time when the plant may vary suddenly and give opportunity for much more rapid development, a critical point having been reached by previous generations of culture.

It is probable that the final development through which the barberry is made to bear a really valuable fruit will come about through hybridizing the familiar species with somewhat different relatives from other lands.

Material for such hybridizations are now in hand, as I have large quantities of seedlings of six or seven different species.

Two of these species came from the Patagonia and Chili regions. One is a plant called *Berberis buxifolia,* and known to the natives as Calafate. Like many of the barberries the plants are quite thorny. The berry is blue-black in color and the natives of Chili use it to make a liquor said not to be unlike gin.

In addition to this foreigner and a Russian species which produces black fruit, there are several native species that may perhaps be advantageously brought into the cross when the hybridizing experiments are undertaken.

These include the two western barberries (*Berberis repens* and *Berberis acrifolia*), sometimes classified as a subspecies called *Mahonia,* and colloquially sometimes called Oregon grapes, because of the clusters of bluish-black fruit. These are both handsome dwarf evergreen shrubs abundant from British America to Central California, also in Colorado. There is also a purple-leaved variety, otherwise not unlike the common barberry, and there are varieties with variegated white or yellow leaves and varieties bearing white, yellow, and black fruit in striking contrast to the red fruit of the common species. Moreover there are varieties that bear fruit that is altogether seedless.

All in all, then, there is opportunity for such blending of racial characteristics as should give the hybrid barberries an impetus to variation, and afford opportunity for rapid development.

My experiments in selection may be regarded as constituting pioneer work, and as affording material for the hybridizing experiments through which the plant may be perfected as a fruit

The Fruit of the Strawberry Tree

This fruit looks good enough to eat, but is not. It would seem, however, that the fruit might be developed and have edible qualities. The strawberry tree is known to the botanist as Arbutus unedo. There are several allied features of arbutus, and it is possible that, through hybridization, varieties may be produced that will have better fruiting properties. Doubtless a good many of our cultivated fruits were less promising in their original wild state than this fruit of the strawberry tree.

bearer. Already the fruit has been made large and of better flavor, and the seeds have been minimized. With the aid of crosses of the species named, and also, probably, with the introduction of the racial strains of a wild species of western Texas, Utah, and Mexico (*Berberis fremonti*), which I now have under culture, and which sometimes bears fruit of exceptional size and superior quality, though not as abundantly as most other species, it should be possible to produce a new race of barberries that will be a valuable addition to the rather meager list of small fruits.

Improving the Elaeagnus

During the early years of my work in California I kept in close touch with all the importations made from Japan by the H. H. Berger Co., of San Francisco, and others. From them I received, among other plants, a curious fruit-bearing plant from Japan, known in its native country as the Goumi Berry, and classified by botanists as *Elaeagnus longipes.*

No other importation of a member of this genus had hitherto been made, so I viewed the plant with particular interest, and was especially struck with the seeming possibilities of improving its fruit.

The *Elaeagnus longipes* bears flowers of a bright, brownish-yellow color, subject to a good deal of variation. The fruit is a berry of varying

shades of crimson, rarely changing to yellow. The flavor of the fruit is far from inviting. After one has tasted five or six of the berries, one is scarcely able to describe the flavor or to decide whether others have any desirable quality.

The astringency of the fruit is so great as nearly to obliterate one's sense of taste after two or three have been tested.

Perhaps it should be noted that the tasting of fruit for the purpose of testing its quality becomes a rather unwelcome task for the fruit developer even when the fruits under consideration are plums or peaches or other orchard fruits of the finest quality.

Visitors have often assured me that they would consider it a very great privilege to test different fruits by the hour.

But such an offer only showed their inexperience. No one cares for fruit after he has eaten a certain quantity, and the necessity of tasting one kind after another becomes for the fruit developer who operates on a large scale a highly distasteful task. If this is true when fruits of fine quality are in question, it must obviously be doubly true of undeveloped fruits like the Goumi Berry, the eating of which gives nothing but discomfort from the outset.

But it is equally obvious that no progress can

be made unless the fruits are constantly tested in order to select the best for the continuance of the experiment. And as there is no known substitute for the human palate in making such selection, the tasting of fruits must be regarded as an unavoidable part of the plant developer's every day work.

In the case of the Goumi Berry, my efforts at selective breeding have been rewarded by the notable progress of the plant, first in the elimination of the thorns, and secondly, in the improvement of the fruit.

Here and there I have found a seedling, the fruit of which is pleasant to the taste, and by selection through successive generations a variety of Elaeagnus has been produced that gives great promise of eventually growing a fruit of real value.

My experience with the genus has included tests of five species, all imported from the Orient, bearing the specific names of *Elaeagnus augustifolia, E. umbellata, E. pungens,* and *E. argentea,* in addition to the original *E. longipes.* There are three closely related plants also belonging to the Oleaster natives of North America, these being, *E. canadensis* (sometimes called *Shepherdia canadensis*), *E. argentea,* the buffalo berry (sometimes called *Shepherdia argentea*), and *E. argentea,* the

Fruit of the Hawthorn

The familiar hawthorn is a distant relative of the apple, as its fruit suggests. For some reason or other, however, its fruiting possibilities have been neglected. Mr. Burbank thinks that it should be possible through selection, with or without hybridization, to produce a hawthorn bearing fruit of very commendable quality. The prospect of adding a new member to the not very large list of orchard fruits is alluring.

silver berry of the far west; all somewhat similar plants in general appearance, but quite different from the Elaeagnus of the eastern hemisphere. The seeds should be treated like those of the pear —removed from the fruit when fresh, thoroughly washed, and kept fairly moist until planting time.

The seedlings grow rather slowly at first, but offer no particular difficulties.

I have made various attempts to cross the different species, but thus far without success, chiefly because the plants bloom at widely different seasons.

Up to the present, therefore, the improvement has all been due to selection and to crossing within the species. After many years of selection my stock has finally been reduced to a single plant, a large bush bearing most abundantly each season. The fruits are large and of very good quality. Indeed, the improvement has been so marked that it is not unlikely that this variety, when it has been more fully tested, will be introduced. It has certain attractive qualities that seem to make it worthy of a place in the fruit garden.

The best varieties of the American Elaeagnus, especially the buffalo berry and the silver berry, are well worthy of cultivation, and extremely promising for work, being enormous bearers of pleasant-flavored, currant-like fruit, which in the

wild state is often collected for making jellies, and is far better in quality than the goumi berry of Japan, although very much smaller.

The best of all these species bear fruit in astounding quantities. The crossing of the best varieties of the American and the Asiatic Elaeagnus gives as good promise of important results as any fruits that I can mention.

A Unique Chinese Fruit With Green Flesh

Another importation from the Orient that seems pretty certain to be welcomed here, is a plant indigenous to China, belonging to the genus *Actinidia*, known to the natives as the mao-li-dzi.

The English interpretation of this word is said to be something like "Hairy Plum."

As described by a missionary from whom I received the seeds of the plant, the Hairy Plum grows as a vine, and has a fruit with bright green flesh, containing seeds not unlike those of the strawberry, and with a thin brown skin covered with a downy coat like that of the peach. The fruit is said to resemble the strawberry in taste. It is described as delicious when raw, and also as very good when cooked.

My informant further states that the seeds are obtained from a plant growing in the mountains at an altitude of about five thousand feet. He declares that the fruit is popular, and that efforts

have been made to induce the Chinese to make a business of growing it, but that hitherto it has been necessary to depend entirely upon plants growing wild in the mountains.

The vine clambers over the underbrush on the mountainside like a grapevine. It is, of course, very hardy.

One of the attractive features of plants of this tribe is the ease with which they may be propagated. Not only can they be grown readily from seed, usually producing new varieties, but they grow also from soft or hard wood cuttings, from tip cuttings, or by layering.

When a new variety is produced of the desired type, it can be multiplied indefinitely by dividing any part of the plant into sections and placing these under conditions suitable for growth.

Some of the plants of the genus are true climbers. Most of them, however, trail upon the ground, usually hugging it closely. Those that climb are valuable for covering screens, arbors, walls, and low buildings. The trailers are valuable for decorative purposes and quite often for their fruits.

In Corea and Manchuria the long, slender vines of *Actinidia polygima* (the species with which my experiment began) are used for cordage.

Other species are used in the manufacture of paper.

A Bush of the Juneberry

The Juneberry is one of a number of interesting shrubs belonging to the rose family. The common form, known to the botanist as Amelanthier botryabium is a native of the eastern United States. It bears a juicy fruit of fairly good flavor, which merits the attention of the plant developer. There is every prospect that it will prove susceptible of great improvement.

My first introduction to the genus was through a number of large plants of *Actinidia polygima* received in 1904 from an American miner in Corea. The seeds already referred to were received five years later. The first fruit buds appeared on the plants in 1912. But different species vary as to the age at which fruiting begins. Some species fruit in the first year from the seed.

The ones under my observation have fruited too recently to enable me to do more than observe their attractive qualities, and form a general opinion as to the possibility of improving them. I have, however, after testing fruit from a number of species, selected an extremely hardy, rugged variety from the high mountains of Western China that bears a really delicious fruit.

The vine may be grown as readily as the grape, and its improved varieties promise to be a very valuable addition to the list of American fruits. Its full possibilities of development, however, can be judged only after more extended observations.

Improving the Myrtles

More familiar exotics, some representatives of which have so long been under observation in America that they seem almost like natives, are the various members of the myrtle family. These are curiously divergent. Some of them are small trailing vines, yet the family includes also the

gigantic Eucalyptus trees that grow to such immense size in Australia and California.

True myrtles are mostly natives of the Southern hemisphere. There are representatives of the tribe, however, that thrive in the tropical and sub-tropical regions of our own hemisphere, among these being the plants that grow the fruit known as the Guava.

The species of myrtle that chiefly concerns us in the present connection is a tender shrub with slender branches, known as the common myrtle, and classified by botanists as *Myrtus communis.*

There are numerous varieties of the shrub, some of them bearing white or yellow or variegated leaves. The tendency to produce these variegated leaves may exist as a latent characteristic in the green-leaved variety. I have grown a beautiful variegated variety from the seed of the ordinary green myrtle. As a rule the progeny of the "sport" thus produced tends to revert to the original type. And in point of fact it is observed that all plants with variegated foliage have a very strong tendency to produce green-leaved seedlings.

The fruit of the common myrtle is small, black, and hardly edible. I have imported many species and varieties from Chili and Patagonia, however, which, although appearing very much like the common myrtle, bear fruit quite different in ap-

pearance, being pink, white or yellow. The individual berries are usually as large as huckleberries, sometimes considerably larger, and have delightful aromas and flavors.

Some of these new fruiting myrtles will grow on very dry ground; others require soil that is constantly moist.

At three or four years some of the trees of the Chilian and Patagonian species are used for timber, and grow to a height of twelve or fifteen feet, with a breadth of ten feet. The branches often droop gracefully like those of the weeping willow, and are heavily loaded with oval, small, glossy green leaves. These are not the fruiting species, which grow to a height of two to four feet, and sometimes of equal breadth.

Another species that bears fruit when quite young, sometimes even in the second year, has been received from South America, and is identified as *Myrtus ugni*. This plant bears a curious resemblance to the gooseberry, except that it has no thorns. Its berry is a glossy purple, sometimes slightly hairy, growing in compact drooping racemes like the currant. Some of the berries are of excellent flavor, others woody or filled with seeds.

Several thousand of the best seedlings from these exotic myrtles are now growing on my place,

Purple Barberry

The barberry is familiar everywhere as a hedge plant, but is not commonly known as a fruit producer, the beautiful berries borne by the ordinary species being quite inedible. Mr. Burbank has undertaken extensive experiments in the bettering of the fruit, hoping to give it a marketable quality.

and there are indications that some among them will almost certainly prove of value as fruiting plants for general culture.

All of them appear to be hardy enough to stand the climate of the central United States. It is to be expected that hybridizing experiments will further improve the fruit. The material is now in hand for such experiments.

Some Neglected Relatives of the Raspberry

Not to leave the field entirely to exotics, we must note that there are several members of the great Rubus family, closely related to our cultivated raspberries and blackberries, that grow at our very door, so to speak, yet which have been hitherto neglected or given slight aid in the development of the latent fruiting possibilities we may confidently expect in most members of this family.

Among these are plants of a group represented in the eastern United States by the Flowering Raspberry, *Rubus odoratus;* in the central region by *Rubus deliciosis* of Colorado, and along the Pacific Coast from Alaska to Southern California by the Thimble Berry, *Rubus nutkanus.*

The eastern species is a handsome plant with deep, pink flowers that make it suitable for ornament. The Thimble Berry grows among the weeds of the lower hills and valleys, sometimes climbing high up the mountain slope, and in Southern

The Stem of the Russian Barberry

The barberry is well known to be a very thorny plant, but the Russian species is peculiarly well armed, as this picture testifies. Now that thornless blackberries are in evidence, the plant-developer will be expected to remove the thorns from the barberry at the same time that he improves its fruit.

California seldom venturing below an altitude of five thousand feet.

No other shrub on the Pacific Coast exhibits a more pleasing effect than a broad expanse of the soft, delicate, green foliage of the Thimble Berry. Its large, white flowers, flat, button-shaped red berries, and sweet, resinous, woody fragrance add to its attractiveness.

The flowers of the Thimble Berry are not so large as those of its eastern relative, but their delicate, pure white petals scattered among the large, pale green leaves, add to the beauty of the banks of foliage that overshadow the other forest flowers. The thin, button-shaped berries are often of a brilliant red, though sometimes paler, but are extremely soft so that they can be picked with difficulty. The fruit, though edible, is of little value, being somewhat acid, and lacking flavor.

Yet the aristocratic lineage of the plant makes it seem probable that its fruit may be susceptible of development.

I have attempted to cross the Thimble Berry with nearly all cultivated varieties of raspberry and blackberry, but have never succeeded in effecting hybridization, unless this has been effected in some hybrid seedlings of last season, which from the foliage would appear to have resulted from a cross.

A Russian Barberry Bush

Mr. Burbank has followed his usual custom in going to different countries for material, in his hybridizing experiments in the attempt to improve the fruit of the barberry. A plant of the Russian species which is being utilized along with others is here shown.

The *Rubus deliciosus,* the Colorado species, is similar to the eastern one in most respects, except that the blossoms are white. All three species are almost thornless; the Colorado species practically wholly thornless, though the fruit of none of them is of any value. The hardiness of the Thimble Berry and its trailing habit suggest interesting and unexpected possibilities for its fruit, if a cross could be effected that would introduce the lacking elements of size and texture and flavor.

Other Rubuses that seem worthy of attention are the Bridal-rose, *Rubus rosaeflorus,* and the Wine-berry, *Rubus thoenicolasius,* both natives of Japan and China.

The former is a double-flowering plant, often cultivated for its flowers. It thrives well in California in cool, shady places. The double-flowering varieties, in my experience, do not fruit, but there is a closely related form that produces single flowers that mature fruit of an inferior quality.

The Wine-berry was introduced into America about twenty years ago by Mr. John Lewis Childs. As an ornamental plant it is quite promising. But its fruit, in its present state, is of no value.

The bright, cherry-red or sometimes salmon-colored berries are usually small and soft, slightly acid and insipid.

But the strong, graceful, recurving branches,

The Texas Barberry

This shrub differs very markedly in appearance from the one shown in the preceding picture. Interesting results may be expected when the strains of the two are blended through hybridization. By combining the strains of divergent species such as these, Mr. Burbank has attained some of his most notable results.

and the large ample leaves, with their white under surfaces, make the Wine-berry a beautiful and attractive shrub. And although the experiments that have been made with it on my farms have not suggested great promise as to fruit production, yet I wish to state that the experiments were not conducted extensively, nor for a long period, and do not regard them as conclusive.

Pending further investigation, the wine-berry must be regarded as possibly presenting opportunities for the development of a new fruit-bearing Rubus.

Conceivably the attempt to hybridize this species and the Bridal-rose or the ordinary raspberries might lead to interesting results.

Fruit-Bearing Shrubs

Among other plants with undeveloped fruiting possibilities are some shrubs of the heath family (*Ericaceae*), relatives of the rhododendrons among flowering shrubs and the huckleberry among fruit bearers.

Of these the best known is the form of Arbutus called the Strawberry tree. This is commonly grown both in Europe and America, and considerably prized as an ornamental shrub. It is a small shrub, varying a good deal in size, but commonly growing to the height of about six feet.

It bears berries that vary in size and color, but

which in general are red, suggesting the common name given the shrub.

There are several other species of Arbutus, among them some of the most beautiful trees and shrubs for the adornment of lawns. One of the most prized species is the California form known as the Madrona, which sometimes grows to a height of about one hundred feet, and which bears ovate leathery leaves not unlike those of the Magnolia.

This tree is quite hardy, even in the mountains of California, its native home, and its leaves, blossoms and fruit are ornamental and attractive. The blossoms grow in clusters, sometimes erect and sometimes drooping. They are white in color, and very fragrant. The berries, orange or scarlet in color, somewhat resemble those of the Unedo or Strawberry tree, but the clusters are more numerous and smaller.

A singular thing with regard to both of these forms of Arbutus is that blossoms and ripe fruit may be seen on the tree at the same time. In this respect the Arbutus resembles the orange tree.

I have often thought that a handsome tree could be produced by crossing the Unedo or Strawberry tree with the Madrona, and I have no reason to doubt that the cross could be made. I regard the Arbutus as a promising tree for experimentation.

My own experiments with the shrub have been confined to the raising of seedlings for ornamental purposes. I observed that the Strawberry tree, like the Madrona, varies in size and sometimes in shape and color of leaves and fruit. I am confident, therefore, that by special cultivation and selection the Strawberry tree might be improved and made to bear a very fragrant and luscious fruit.

Various members of the genus are available, and there is good prospect that experiments in selective breeding, with or without hybridization, would reward the experimenter.

Two other shrubs that give good promise are the Hawthorn and the Mountain Ash. The Hawthorn in particular is an extremely valuable shrub, and gives very great promise of the production of improved varieties of fruit through selective breeding.

The Mountain Ash is usually raised for the beauty of its fruit. I have made experiments in selective breeding with this plant, and have greatly improved the size and beauty of the clusters of fruit. With the Hawthorn also I have made some interesting experiments, but there is fine opportunity for other workers in this field. Indeed, the work of developing this fruit has made only the barest beginnings

The Fruit of the Barberry

These clusters of barberry fruit represent varieties improved by Mr. Burbank through selection. The plants on which they grew will be utilized for further development in crossbreeding and additional selection. It will be seen that the fruit already has a very promising appearance.

I would especially emphasize the fact that there are peculiarly inviting opportunities open to the amateur in connection with this familiar but almost totally neglected plant.

The hawthorns are hardy shrubs or small trees, of vigorous growth. There are about seventy species available for hybridizing experiments, and some of them already bear fruit that seems fairly to beckon the would-be developer.

Doubtless the original apple—the progenitor of all modern varieties—was no better than the best of the present native hawthorns. Who will give us a new race of fruits to compete with the apple, through bringing out the only half-hidden qualities of this responsive shrub?

—Largely by chance, certain plants have come under the tutorage of man, and thus have been brought about the familiar fruits of our orchards, vineyards and berry patches; who can predict the surprises which the orchards and vineyards and berry patches of the next generation will reveal?

The Need for Improving Small Fruits

And Some of the Means for Meeting It

WITH the present chapter we conclude our survey of the fruits proper, and it will be well to make a brief review of the subject, in particular with reference to the outlook, and the possibilities of further progress in the near future.

In making this general review, we need not confine attention absolutely to the small fruits. Much that is said will refer to fruits in general.

But doubtless there are larger opportunities for improvement with the berries and garden fruits than with the familiar orchard fruits, chiefly because the latter have been given a far larger share of attention by the horticulturist and fruit developer in the past.

The large size and varied uses of apples, pears, peaches and plums, in particular, have made them popular everywhere, and have caused a vast deal

of attention to be given them. So almost numberless varieties have been developed which meet the most varied requirements. But the small fruits have been the Cinderellas of the pomological family. Our own generation was first to give them proper recognition, and it remains for our successors to carry them forward to their true plane of utility.

So it is these fruits rather than others that we shall have chiefly in mind, as the title of the present chapter would suggest. But I repeat that much that will be said applies to all marketable fruits, and even where a particular species is referred to, what is said is often susceptible of general application.

Bearing this in mind, let us briefly review the story of the modern development of the small fruits, and with equal brevity outline a few suggestions as to the lines of future progress.

The Increased Consumption of Fruit

The consumption of fruit has increased more rapidly in the United States, and perhaps throughout the world, during the last one hundred years than has that of any other kind of food, with possibly the exception of nuts. The increase in the consumption of both fruits and nuts during the past twenty years has been particularly remarkable, and they are in fact coming to be

regarded as food staples, as they certainly should be.

As an illustration, take the case of the strawberry. This was about the first small fruit commercially grown in the United States to any great extent. Early in the 19th century a few were raised in New Jersey for the market in New York City. Those who first engaged in this enterprise soon found that to keep up with the increasing demand, it was necessary to go into the business on a much larger scale, and raising strawberries by the acre for the market became an industry.

At the time it was prophesied that there would be an over-production of strawberries, and that they could not be sold. But now whole train-loads of strawberries and other berries are brought into New York City daily during the season.

Probably a carload of strawberries is consumed today in the United States to every cultivated strawberry that was eaten one hundred years ago.

The consumption of the tree-fruits, grapes, and other small fruits has increased in a somewhat similar proportion.

America has had an important share in recent fruit advancement. When the immigrants came from other countries to America they usually brought with them some of the seeds or cuttings of their favorite fruits; these were planted and

orchards were grown. And in the course of events, when the families began moving westward, they usually selected seeds from their best fruits for transplanting.

In this way a constant and natural selection has been going on from the very first; the poorer varieties being discarded and forgotten, while those that filled a want and had proved productive and valuable were cherished.

After this sifting process of the years, only a few of the older fruits, in proportion to the number now cultivated, are still considered standard varieties.

Especially during the last twenty-five years, new varieties of strawberries, raspberries, blackberries, currants, gooseberries, cherries, plums, prunes, apples, pears, peaches, nectarines, quinces, figs, and oranges have been produced and are now favorite fruits.

The old varieties of these fruits, however, are slowly but surely being supplanted by still later productions.

New Varieties to Meet New Conditions

This process of evolution is wholly imperceptible to the careless observer; but to one who watches closely the development of fruits, there is an unmistakable and rapid change now going on. Old orchards are continually being grafted

Fruit of the Chilian Myrtle

This is another of the almost numberless tropical species with which Mr. Burbank has experimented in the endeavor to develop new types of orchard and garden fruits. The berry of the Chilian myrtle has a pleasant odor and taste, and there is sufficient variation to suggest the possibility of improvement through selective breeding. It may prove possible, also, to cross the plant with one of the other myrtles, stimulating variation, and giving further opportunity for selection.

over to new and improved varieties, while the new orchards added from year to year are planted to the latest standard fruits.

This is especially true on the Pacific Coast, as competition is keen and the tests given fruits must be exacting.

Luscious, sun-sweetened fruits must be produced which will bear shipping long distances, to less favored climes, retaining their form, color and flavor. Transcontinental shipping is one of the severest tests that can be applied to any fruit—and it is distinctly a new test.

Most of the older fruits had been selected for family use and home marketing; very few of them consequently could meet this new requirement.

Notwithstanding the fact that practically all the best fruits in the world have been tested in California, only a few of the Eastern or European varieties have been able to meet the conditions here, and to fulfill all the requirements demanded. At present probably one-half of the fruits grown in California, with the exception of the French prune, are varieties that have originated, or at least have risen to commercial importance, within the state; and this statement applies with almost equal force to the states of Oregon and Washington.

There is a great field of usefulness open to the

enterprising plant breeder in the adaptation of fruits to different localities and climatic conditions, thereby extending the belt in which certain fruits can be raised.

Some regions are too arid; some too cold, others too warm, or too damp and with too frequent rains for certain fruits. It is the mission of the plant-breeder to develop varieties that will withstand these conditions.

What greater good can be accomplished than making exquisite fruits that will grow abundantly in sections of the country where none could be grown before?

Climate, Disease, and Human Tastes

In creating new varieties to meet local conditions, it is usually necessary to bear in mind not alone edible quality of fruit, but the constitution of the plant itself.

Hardiness is often a *sine qua non*, particularly with fruits intended for the new regions of the Northwest, where the winters are extremely cold.

Then nearly all kinds of fruits are subject to fungous diseases of some sort. These must be combated by developing hardy, resistant varieties. Some advancement has already been made in this direction; but much remains to be done. The careful plant-breeder will watch intently his stock and promptly discard all susceptible plants.

It is in this way alone that such diseases can be thoroughly and permanently conquered.

In some parts of the United States the sun's heat is too fierce and the air too dry for fruits to thrive which have been accustomed to more favorable conditions.

For such regions varieties must be developed which are low, compact growers, producing an abundance of thick, leathery leaves, and fruit that will not easily sunburn. Some of the Eastern varieties, having become adapted to a moist climate, are open growers, bearing rather thin, delicate leaves. Such varieties are usually total failures when introduced in the arid Southwest.

In developing a new fruit, the plant-breeder must not only meet the exacting demands of Nature, but also the exacting and increasingly complicated demands of the grower, the shipper, and the consumer; for together they constitute the jury that finally determines the value of his product. The tests of these jurists are applied from different standpoints and for different purposes.

The grower is solicitous for an early-bearing, prolific tree, immune to fungous diseases or insect pests; one that will flourish with little care, pruning, or other attention.

The shipper and dealer are unconcerned about the characteristics of the trees, or their produc-

The Elaeagnus or Goumi Berry

The original Goumi berry, as imported by Mr. Burbank from Japan, was a very astringent fruit, and with a very thorny stem. Through selective breeding Mr. Burbank has had good success in eliminating the thorn and in improving the fruit. He has made experiment tests with five species of Elaeagnus, all imported from the Orient.

tiveness, but they are eager for an attractive fruit —large, bright-colored, handsome; in particular for one that is very solid—so hard that it can be handled like a cannon-ball, which makes it a superb shipper.

The consumer, on the other hand, prefers a reasonably tender, highly flavored, and easily digestible fruit.

Unfortunately the consumer seldom obtains such a fruit unless it is grown nearby or within his own community; for the ideals of the shipper and the dealer, at variance with his preferences, intervene between him and the orchardist.

For instance, better varieties of strawberries for table use have been developed than can be found in any market; better in quality, aroma and sweetness. The average consumer is never permitted to see them, or to experience their lusciousness. They are eliminated from the growers' list of fruits, because they do not meet the demands of the shipper and the dealer.

The consumer usually obtains the best that the producer, the shipper, and the dealer can furnish, under the conditions with which they have to contend; the fault is not theirs, but that of modern civilization.

I mention all this merely to show that varieties the production of which is useful and profitable,

Blossom of the White Elder

In recent years Mr. Burbank has paid a great deal of attention to the improvement of the elderberry. The elder is a familiar small tree growing wild in many regions of the United States, and its berries are sometimes used for making pies, but are hardly considered a marketable product. Mr. Burbank has shown that the fruit has possibilities of development.

are not necessarily the most desirable for food purposes.

Consumers Must Be Educated

Yet the fault does not lie exclusively with the dealers. When a new fruit is first introduced it is difficult for the people to become adapted or accustomed to it, if it possesses new and strange peculiarities and qualities that are not understood or appreciated.

I have found that it is just as difficult to adapt the people to a new fruit as it is to adapt a new fruit to the people.

New varieties that at first are condemned, may be accepted later as standards, and become practically the only ones grown. The same law seems to hold true with fruits as with new ideas and new inventions in general; often these are at first condemned, but if possessing genuine merit they are finally recognized and appreciated.

I have met this experience in the introduction of nearly all the new fruits that I have produced.

It was ten years after the Burbank plum was introduced before people generally discovered that it was a valuable fruit. Now it is planted more widely than any plum on the globe, and thrives in almost all regions where plums can be grown.

The excellent properties of the Wickson plum,

A Cluster of White Elderberries

These are selected berries, unmodified by hybridization. There are several species of elders, and some of them show a marked tendency to vary—a trait that is always attractive to the plant developer, since it gives him material with which to work.

now raised in most localities where plums are cultivated to any considerable extent, were for several years unrecognized. To-day it is acknowledged to be the best shipping plum in existence, not only in America but in Africa, Australia, New Zealand, South America, and even in Japan.

My Van Deman and Pineapple quinces were not very well received by some when first introduced; at present they are probably planted more than any other quinces in California, and everywhere acknowledged to be the best in quality, and in most of the eastern states the first-mentioned is considered the only variety worth growing, succeeding above others even in the coldest climates.

But little merit was seen in the Phenomenal berry when first introduced, but during the past few years until quite lately the demand for the plant could not possibly be met.

When the Crimson Winter Rhubarb was first introduced, the rhubarb growers in California paid no attention to it, and for some time refused to plant it at all. More recently, fortunes have been made in California and other regions having a mild climate by its culture, and to-day it is practically the only rhubarb being planted in all mild climates. People did not understand its new and peculiar characters and qualities; time was required to educate them.

A Burbank Hybrid Elderberry

Mr. Burbank has utilized all of the species and varieties of elder that he could obtain in his hybridizing experiments. The fruit here shown represents a stage of progress. Its improvement over the original is so notable that Mr. Burbank entertains no doubt as to the ultimate outcome of his experiments. He believes that an elder bearing a fruit of genuine value will be developed.

The same might be said of the Shasta daisy and several scores of other plants, and nuts, flowers, fruits and ornamental trees and vegetables which have been produced on my grounds.

I have learned through experience that no new fruit will be fully appreciated, or its qualities generally known or recognized, for at least ten or twenty years.

Corn, beans, peas, cucumbers, and similar plants can be tested in six months and accepted or rejected; but it requires years to test a new fruit so that its qualities may be thoroughly and generally appreciated.

A Recapitulation of Methods

We have seen that the adaptation of fruits to certain localities may be accomplished either by importation of plants developed elsewhere, or by producing the seedlings on the grounds, and selecting those that prove best adapted to the local conditions.

In either case, a thorough study of each type of fruit in view of the needs and requirements of the location is absolutely necessary, in order to achieve success in the adaptation of the fruit.

A section of country where strong winds prevail will require a fruit-tree with compact form and of firm wood.

In climates of brilliant sunshine the tree must

be protected with an abundance of thick, heavy foliage.

Some trees will not thrive in a dry soil; others fear moisture. And there may be differences as to these propensities among plants grown from the same lot of seed; and, indeed, from seeds produced by the same plant.

Therefore not only the type but the individuality of the plant must be considered, adapting it to certain conditions.

If the quality of hardiness in fruit is required it may be attained through proper methods. In regions where insect and fungous diseases thrive it is necessary to evolve fruit-trees which are resistant to such pests; and there is no other way of reaching a satisfactory conclusion regarding their resistant powers than to grow them where they are exposed to their foes.

All of this cannot be accomplished in a brief time. It requires the most persistent labor and unyielding patience.

Any recognized "fruit quality" can be intensified, almost any desired quality can be attained, through intelligent observation, selection, and patient waiting. But not without toil; nor without careful heed to such measures as will assure the co-operation of Nature.

Says Emerson: "The ripe fruit is dropped at

last without violence, but the lightning fell and the storm raged, and strata were deposited and uptorn and bent back, and Chaos moved from beneath, to create and flavor the fruit on your table to-day."

Let the plant developer ponder and heed that saying, and realize that at best it is given him not to create or overturn, but only to have a slight selective and directive influence in the great Scheme of Plant Evolution.

Foundations of Heredity

We have viewed in detail the story of the development of the different fruits, and have observed many anomalous products.

We have witnessed the creation of new species, and have seen that rules applying to the hybridizing of certain forms appear to be quite abandoned in the hybridizing of others.

But of course we know that the underlying principles are everywhere the same, and that seeming divergencies in their application to different species are but modifications of the same laws to meet varying conditions. The wise plant developer must be able to look beneath the surface and discover the underlying harmonies. Otherwise he will often make mistaken interpretations, and will perhaps give up an experiment when the goal was just within reach.

Blossom of the Mountain Ash

The mountain ash is another familiar tree that has been highly appreciated for its ornamental qualities, but quite ignored as to its fruiting possibilities. The flowers here shown are premonitory of big clusters of fruit that will be very attractive in color, but edible only for the birds.

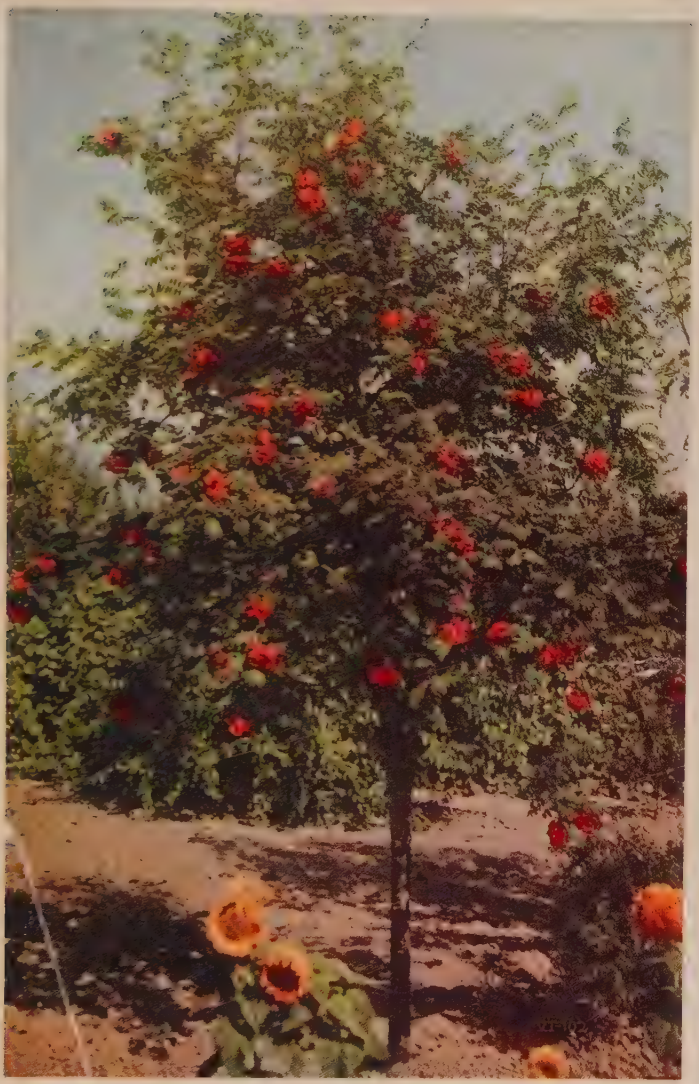
Perhaps it may be helpful if now, by way of summary, we review in their broader outlines, a few of the principles that have been illustrated by specific cases in the preceding volumes, and offer an added word of explication that may be of aid to the general reader in clarifying his view of complex plant hybridizations, and to the plant experimenter in giving clews that may prove advantageous in his work in the field.

Let us recall, as the text for our first illustration, the simplest case of plant hybridization.

When, let us say, a thorny and a thornless blackberry are crossed, the offspring are all thorny. But in the next generation a certain proportion of the offspring are thornless. A corresponding case is that of the ordinary blackberry crossed with the white blackberry. All the offspring of the first generation are black, but whiteness reappears among their descendants.

Let us recall, further, that the process of hybridization consists essentially in bringing the nucleus of the pollen cell in combination with the nucleus of an egg cell.

Also let us bear in mind a computation that we were able to make with the aid of the physicist, by which we were made aware that the germ cell itself is a highly complex structure with diversified component parts, each of which may be



Mountain Ash Tree in Bearing

The avidity with which robins and other species of feathered bon vivants consume the fruit of the mountain ash suggests that these berries have qualities that might appeal to the human palate, if somewhat modified. Mr. Burbank has acted upon this suggestion, and has brought the mountain ash into his garden and taken it under tutelage. The results will be shown in later pictures.

thought of as having as much individuality as any member of a developed organism

We saw that, even if we considered the individual parts or members of a germ cell to number a thousand or more, there are available many billions of atoms to make up each member.

Let us then, finally, recall the teaching of the modern biologist, who gives us reason to believe that, just as each individual higher organism is produced by the union of two complementary elements, male and female, so there is union of complementary elements within the intimate structure of the ovule itself to form each new character. That is to say, using the accepted terminology, it is necessary in building up any character that is to be made manifest in the future adult organism, that there shall be a blending of two hereditary factors, which we may now think of as individual members of the germ plasm colony or organism.

For example, there are factors of thorniness and factors of thornlessness in the germinal cell of the blackberry.

There are color factors for blackness and for whiteness in the case of our other blackberry.

It may be in any given case that the two factors united both represent thorniness, in which case the future plant will bear thorns. It may be, on the other hand, that the two factors both represent

thornlessness, and in that case the future plant will be thornless.

Yet again there may be a union of a thorny factor with a thornless factor; and in this case, as we have seen, thorniness will prevail because, as we say—although, of course, our explanation only states the matter over again in another way—the thorny factor is dominant and the thornless factor recessive in this particular combination.

Changing our terms to suit the case, the same principles apply to our black and white blackberries.

And in each case, it will be recalled, the germ cell that bears only dominant factors will breed true to the dominant quality; the germ cell that bears only recessive factors will breed true to the recessive character; and the germ cell that bears the two conflicting factors will have progeny in which these factors are separated and reassembled in various combinations, thus accounting for the reappearance of the latent or recessive character.

Heredity Visualized

All this is familiar to us and has been illustrated over and over again from practical cases in the course of our studies.

And we have agreed that the really mysterious part of the entire process is the fact that the hereditary factors are able to combine with such

certitude and grow and multiply and reproduce themselves indefinitely.

This part of the procedure is indeed mysterious and beyond the fathoming of the human mind.

Yet perhaps it may be made to seem at least a little more tangible and explicable, even if not less mysterious, by an interpretation in which we are permitted for once to make use of the imagination. Suppose we imagine the existence within the complex structure of the infinitesimal germ plasm organism of a being of human intelligence, but of atomic proportions—an elf that has control of the hereditary factors, considered now as material entities, and directs their use in the building up of a new organism, somewhat as a human architect directs the use of material in the construction of a human habitation.

Let us then assume that the material making up the nucleus of a pollen cell as it comes to the ovule of a flower and is brought in contact with the nucleus of the ovule, is in charge of one such elfin architect, and that the materials of the nucleus of the ovule itself are in charge of another elfin architect. The task of building the new structure that is to result from the union of the two nuclei devolves upon these two elfin architects jointly. They must work in co-operation and their decisions will determine how the hereditary

Fruit of the Wild Mountain Ash

Looked at individually, these little fruits certainly suggest an apple, and they invite the plant developer. As an abundant bearer, the plant leaves nothing to be desired. It is only necessary to increase the size and improve the quality of the individual fruit.

factors shall be combined in building the new organism.

Suppose, now, that the particular case that is before us is that which arises when some colossal plant-developer with his crude manipulations has succeeded in transferring a pollen grain of a thorny bramble that bears white berries to the pistil of a thornless bramble that bears black berries, and that the respective nuclei of pollen-grain and ovule have come together.

The elfin architects compare notes, inspect their respective blue prints and charts and tables of specifications, and set to work. For a time they get on very well. There are factors for general size and foliage and form of plant; for time of flowering and appearance of flower cells; for root system and shape of leaf and shape of future fruit, and a multitude of other details in regard to which there is perfect agreement. In all these cases the factor that *A* represents fits perfectly into the factor that *B* represents, and the work of building the future plant goes on apace.

But presently, as they have built upward from the root and outward from the center, they come to the specifications for texture of stem.

And here at once there is disagreement.

Elf *A* finds that his specifications call for a thorny stem, but the factor that elf *B* represents

calls for a smooth stem. And at once there is a quarrel.

"Whoever heard of a brier bush without protective briers?" demands elf *A*.

"I have the honor to represent such a one," says the other.

"But the thing is a departure from all the traditions of good brier architecture," insists *A*. "Moreover you cannot possibly fit the materials together without getting some brier material." And this argument prevails.

When the factors are examined, it is obvious that if they are put together the thorny factor will overlie the thornless one, somewhat as a carved stone might overlie a smooth stone in a human dwelling. So it is admitted that the new organism must have a thorny stem.

Now all goes well again until the two architects come to the building of the future fruit. Character of flowers, time of fruiting, and general structure of the berry itself are all arranged. But just as the last detail was almost completed there is again a disagreement. It is discovered that *A's* plan calls for a white fruit, *B's* plan for a black fruit.

"Whoever heard of a white blackberry?" demands *B*, turning thus rather neatly the argument that the other elf used about the thorns. "The thing is ridiculous."

"I represent a white blackberry," *A* replies, let us hope with dignity.

"Well, there isn't any way of blending white paint and black and keeping things white, is there?" *B* continues. And this argument is conclusive. The two color factors are assembled, and it is conceded that the future plant will bear black fruit. The black pigment overlies the white like a double coat of paint, and a black fruit is provided for.

When the elfin architects have finished their task, then the factors representing the materials of the two germ cells have all been satisfactorily paired, and provision has been made for a future bramble that will have a thorny stem and will bear black berries—a plant that is unlike either parent, although built of no material except factors drawn from the two parents.

Recall, however, that the factors for thornlessness and for white fruit were not eliminated. They were only overlaid by the opposing factors. They go forward in the germ plasm, each pair of factors being constantly multiplied through division in the mysterious way that characterizes living matter, so that for each factor that entered into the original structure, there are now multitudes of factors.

And in the next generation, when new pairs of

The Result of Education

Contrast this cluster of mountain ash fruit with those shown in the preceding picture. The fruit colony is greatly reduced in number, but correspondingly improved in the size and value of the individual fruits. This result has been obtained by selective breeding.

elfin architects are making their plans, it will be possible to re-assort the materials (in building a large number of new structures that we call offspring of the second generation), making some combinations that will include two smooth-stemmed factors and two white-fruit factors, and thus giving us a certain number of seedlings of this second generation that will have smooth stems and will bear white berries—which chances, perhaps, to be what the crude human experimenter is seeking.

The Architects on Strike

But now let us attend to a case in which a more complex hybridization was made; that, let us say, in which the pollen of an apple was brought to the pistil of a dewberry.

Now we must call attention to a feature that we have ignored heretofore—the segregation of body plasm and germ plasm at an early stage of the union.

The coming together of the two germ plasms gives a stimulus to growth. The berry develeps, and a drupe is formed that is like a dewberry because the body plasm of the dewberry is acting as carrier. That is to say, the dewberry is the pistillate parent.

The elfin architects in a single ovule get together. They separate out the body plasm, and,

although there is conflict, it appears that the material will permit the building of a root and stem and leaf system that will answer after a fashion—though a sad departure from tradition. A big rambling bush that will try to ape both dewberry and apple tree will result.

But in the matter of the architecture of the germ plasm for the new organism through which the race is to be perpetuated, difficulties arise at the outset that are almost disheartening.

There has been trouble enough in getting the factors together to make any sort of stem and leaf and flower. But all this was nothing compared to the difficulties that arise when they get to the fruit.

"Specifications for fruit," says elf *A* consulting his blue print: "A big, pulpy fruit, about four inches in diameter, called an apple."

"Not at all," cries *B*, consulting his own blue print. "The fruit is a small berry about an inch long, with many drupelets each having a seed at its center—in short, a blackberry."

How can two elfin architects hope to harmonize materials like that? It is like getting together two human architects to combine materials for a habitation and finding that the material one has to offer for the house are blocks of stone four feet square while the other has only pebbles.

And as the conference goes on, the points of discrepancy become only the more apparent.

All the differences that are manifest between a blackberry bush and an apple tree, and between an apple and a blackberry—together with a multitude of intimate distinctions that the crude human senses cannot fathom—are represented by factors that obviously cannot blend.

So, after studying the matter over and wrangling about it till their heads ache, the elfin builders give up the thing as a bad job.

Their germ factors lie in separate piles unassembled and incapable of being assembled; and the result is that no provision will be made for fruit in the future plant. In other words the plant will be sterile, and that particular double stream of germ plasm will cease to be perpetuated.

By Way of Summary

This, then, is what may be imagined to occur when there is too great difference of materials. It may be left to the reader's imagination to make for himself a picture of the various activities of the elfin architects in those cases where the diversity between the different hereditary factors is greater than that between the two kinds of blackberries, but less than that between the apple and the dewberry.

We saw in such cases as that of the Primus

Edible Mountain Ash Fruit

The most notable result, up to date, of Mr. Burbank's experiments in selective breeding the mountain ash. Who can doubt after looking at this picture that the fruit of the mountain ash will soon receive much fuller recognition than has hitherto been accorded?

berry and the Sunberry that when the two germ plasms were at just a certain stage of divergence the resulting hybrid presented a compromise of characteristics. We may suppose that the elfin architects in the germ plasm are in such a case to be compared with human architects, one of whom, let us say, presents blocks of stone as the chief building material while the other presents bricks. Stone and bricks cannot be blended, but they may be variously combined, for example, placed in alternate layers, to make a structure that is neither a stone house nor a brick house, although it is a house built of both stone and brick.

In the same way the Primus berry is neither a blackberry nor a raspberry, although its component hereditary factors are all either blackberry or raspberry factors.

But we need not attempt to carry the illustration further. The reader who has followed it may make his own application, in reviewing the facts as to the various results of hybridizing species more or less closely related that have been detailed in the preceding chapters.

To some readers the entire illustration of the elfin architects may seem whimsical. But it is presented in all seriousness in the hope that it may serve a useful purpose. Not that I would

for a moment be understood as suggesting that any such infinitesimal creatures with human intelligence are really domiciled in the germ cell. But to personify thus the inscrutable forces through which the building together of the hereditary factors is brought about may serve to give tangibility to the forces of heredity, and to help the reader to memorize the facts already presented, and gain clearer insight into the principles that underlie them.

It may chance that such a personification will enable the plant developer to see a little more clearly into the nature of the phenomena that are presented before his eyes when two plants are hybridized; and that he may thus be enabled to interpret the phenomena in a way that will be to his practical benefit. As elsewhere pointed out, the incorrect interpretation of the early results of a hybridizing experiment may put the experimenter off the track and lead him to give up an effort which would have led to complete success had it been carried forward another generation.

But, in any event, whether or not the reader finds the elfin architects of the germ plasm an aid in his interpretation of the phenomena of heredity, let the would-be developer of new fruits, or the improver of old ones, bear in mind, as the last word that experience can offer on the sub-

ject, the principle that progress must be sought through the careful selection of types that vary in the direction of desired progress; and that in a vast majority of cases such variation may be brought about, and in a sense directed, through hybridization.

[End of Volume VI.]

—The successful plant developer must be able to look beneath the surface of his plants to discover and utilize the underlying ***harmonies.***

List of Direct Color Photograph Prints in Volume VI

Ash

	Page
Blossom of the Mountain Ash	287
Mountain Ash Tree in Bearing	289
Fruit of the Wild Mountain Ash	293
The Result of Education	297
Edible Mountain Ash Fruit	301

Balloon Berries

The Balloon Berry	159
Balloon Berry in Bearing	161
Flower and Fruit	163
The Stalk of the Balloon Berry	165
Interesting Hybrid Berries	169
A Near View of the Hybrid	171
Pure Bred and Hybrid Compared	173
Delicious but Perishable	177

Barberries

Purple Barberry	257
The Stem of the Russian Barberry	259
A Russian Barberry Bush	261
The Texas Barberry	263
The Fruit of the Barberry	267

Blackberries

Mr. Burbank at Work	6
Himalaya Blackberry Bush in Bearing	9
Leaf Variations in a Hybrid	13
Thornless Blackberries	17
Thornless Blackberry and the Recreant Seedless	21
The Himalaya and the Thornless	23
A Thorny Climber	28
A Thornless Contrast	29
Thornless Blackberry Buds	31
Blackberry Blossoms	33
Proof of the Pudding	37

Buffalo Berry

Page
Buffalo Berry 155

Cactus

Cactus Fruit on the Slab..... 212
A Mammoth Specimen..... 215
A Luscious and Succulent Fruit..... 217
Easy to Eat..... 219
Shown in Cross Section..... 221
The Symmetrical Type..... 223
A Pear-Shaped Cactus Fruit..... 225
A Sturdy Variety..... 227
A Nearly Globular Cactus Pear..... 228
A Well-Proportioned Pear-Fruit..... 229
A Cluster of Cactus Pears..... 231
Another Cactus Fruit that Imitates the Pear..... 232
Cactus Fruit Approaching Spinelessness..... 233
Cactus Fruit Approaching Seedlessness..... 235

Currants

The Utah Currant..... 134
Wild Oregon Currant..... 137
South American Currants..... 141
Fruit of the Flowering Currant..... 143

Elaeagnus

The Elaeagnus or Goumi Berry..... 277

Elder

Blossom of the White Elder..... 279
A Cluster of White Elderberries..... 281
A Burbank Hybrid Elderberry..... 283

Goumi Berry

The Elaeagnus or Goumi Berry..... 277

Grapes

Burbank Seedling Grapes.....Frontispiece
In the Vineyard..... 183
Grapes of the Concord Type..... 185
Seedling Syrians 187
An Improved Eastern Grape..... 189
A Mammoth Cluster..... 191
Good Size and Fair Quality..... 193
A Nearly Seedless Grape..... 197
Unproductive but Meritorious..... 199
Faults of Another Type..... 201
"My Early Black Grape"..... 203

Page
The Chinese Wart Grape..... 205
Grapes of the Labrusca Type..... 207
A Fine Specimen..... 209
A Heavy-Bearing Seedling..... 210

Hawthorn

Fruit of the Hawthorn..... 249

Juneberry

A Bush of the Juneberry..... 253

Mayberry

Fruit of the Mayberry..... 145
Canes of the Mayberry..... 147

Myrtle

Fruit of the Chilian Myrtle..... 273

Passion Flower

The Passion Flower..... 241

Phenomenal Berries

The Phenomenal Berry..... 61
The Phenomenal Berry..... 63

Primus Berries

The Primus Berry..... 53

Raspberries

The Familiar Blackcap..... 41
The Eureka Raspberry..... 45
Thornless Raspberry..... 49
The Dictator Raspberry..... 51
The Primus Berry..... 53
A Natural Hybrid..... 55
The Phenomenal Berry..... 61
The Phenomenal Berry..... 63
Hawaiian Raspberries..... 67
An Alaskan Raspberry..... 69
An Interesting Hybrid..... 71
Interesting Hybrid Berries..... 169
A Near View of the Hybrid..... 171
A Pure Bred and Hybrid Compared..... 173

Solanums

A Brazilian Solanum..... 129
A Million Solanums on Trial..... 131

Squaw Berries

Page
Squaw Berry 151

Strawberries

Its Heart on Its Sleeve..... 75
Hybrid Strawberries 79
Plump and Delicious 83
More Burbank Hybrids..... 85
Yet Another Hybrid Variety..... 87
The Patagonia Strawberry..... 89
A Burbank Masterpiece..... 91
A Stage of Development..... 93
A Bed of Hybrids..... 95
The Experiment Progresses..... 97
A Battalion of Seedlets..... 101
An All-Summer Bearer..... 103
The Fruit of the Strawberry Tree..... 245

Sunberries

Sunberries 109
A Sister of the Sunberry..... 113
Sunberry Plant 117
A Relative of the Sunberry..... 121
A Branch of Sunberries..... 125

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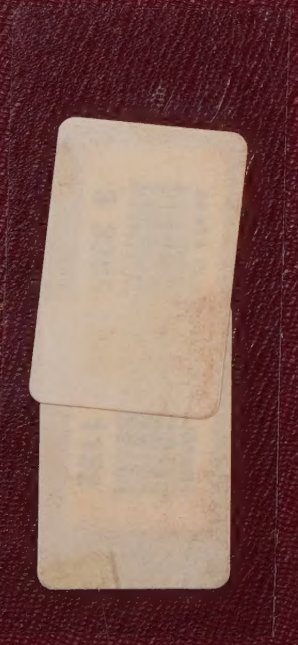
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